SCIENTIFIC AMERICAN

The Monthly Journal of Practical Information

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TAKING THE ROUGHNESS OUT OF OUR HIGHWAYS WITH THE PROFILOMETER—[See page 233]

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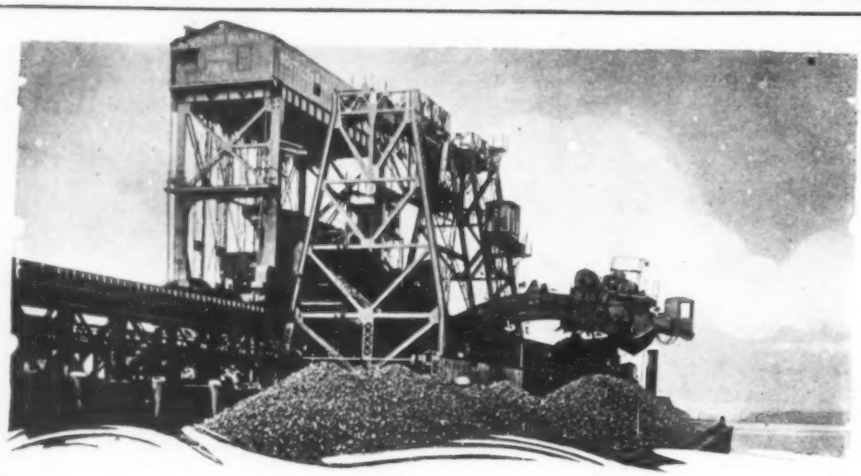

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With the Editors

FACE to face with a serious problem, the inventive mind works at its very best. Indeed, it is the old question of opposition and applied power: you must have opposition or resistance before you can develop power, and the more opposition the human race encounters in its daily struggle for existence, the greater the inventive talent displayed. Just now it is the fuel problem that is confronting us, and what with coal bins scraped out clean and coal mines operating at a very small proportion of their normal capacity, together with the first signs of the coming cold weather, we are all uneasy, to say the least. The factory is faced with the possibility of a shut-down; the office building must curtail its elevator service and lighting and heating facilities; perhaps our schools may have to be closed; and, with the exception of a few lucky families who bought their coal before the present shortage, many of our homes will not be overheated for once. Meanwhile there are many wise heads at work on fuel conservation methods and fuel improvisions. On the one hand we are going to be taught how to make our coal supply do more work than in times of plenty; on the other hand, we are going to be introduced to new fuels as well as renew our acquaintance with discarded ones.

SO the question of the hour is fuel—fuel for the factory, the office building, the school, the public building, the transportation systems, and the home. We have prepared a questionnaire which is designed to draw out from those who know the kind of information which the SCIENTIFIC AMERICAN family seeks regarding the present fuel famine. This questionnaire is being mailed to a large number of fuel authorities. When their answers are received, the mass of information will be digested and arranged for a lengthy article which will appear in our November issue. It will contain the sort of information which you would obtain if you called on half a hundred fuel experts. Don't miss it!

THOSE German gliding contests in the picturesque Rhön valley have attracted the attention of the entire world. On a smaller and certainly less spectacular scale have been the gliding contests held in France, where the contestants could hardly hope to surpass or even equal the records of the more experienced Germans. A motorless flight of over three hours—the three hours and seven minutes' flight made by Hentzen—must mean something of vital importance in the progress of aviation, all comments to the contrary notwithstanding. With all the various contests completed and with a sufficient lapse of time to gather the numerous details, we have assigned to one of our staff the task of compiling all the reports from Germany and France, as well as leading aeronautical opinions regarding "sail-planes" and their bearing on aviation of today and tomorrow, for our November issue. Incidentally, an authority has just told us that it is unfair to compare the German records with the French and American attempts. The Germans have had three years of practical experience in gliding, while the French and American gliding enthusiasts have just started. Again, the Rhön valley selected by the German contestants is ideally adapted to gliding. But why tell the story here in part when it will be told in full next month?

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THE existing order is difficult to upset. Man is a methodical creature. He continues to do things in the same way year after year, and it is only with the greatest difficulty that he can be swerved to another and better way. As we write these lines we have before us a collection of interesting photographs and data on a novel propeller now being experimented with in England. We have two model propellers made by an American inventor along somewhat similar lines to the new English propellers. From the data supplied by the two inventors, it appears that the existing propeller is far from efficient, and something better can and has been developed. Propellers have been designed in much the same manner decade after decade until it seems almost preposterous to suggest a change. And thus it is with so many other things. All suggestions of radical change are generally greeted with the familiar chorus "We have always done it that way; why change?"

NOW the SCIENTIFIC AMERICAN stands for progress—first, last, and always. It does not believe for a single moment that the existing order of things is always the best and only way. For that reason it never hesitates to publish all the new ideas which have merit stamped on their face, and to criticize existing methods which may be at fault. This attitude has made the SCIENTIFIC AMERICAN editorial rooms a meeting place of inventors and engineers and others with new ideas. Obviously, too, this liberal and progressive policy has caused us to be flooded with highly fantastic ideas of little or no practical value. To separate the practical from the impractical is a very necessary function of the editorial mind, and such new ideas as are permitted to occupy our editorial space are, in our opinion, worthy of serious attention. In other words, we have not sacrificed the practical for the sensational. Many, many times we have turned down a most sensational and attractive cover subject for the simple reason that the idea involved did not seem practical. What do you think of this issue? Personally, we believe it measures up to our original specifications of the new monthly SCIENTIFIC AMERICAN.

JUST as we are writing these lines there has come to our desk a letter from Charmian London, wife of the late Jack London. No doubt you have read the wonderful Jack London novels; perhaps you have been fortunate enough to read the touching story of Jack London's life, written by Charmian London. "Last evening," writes Mrs. London, "reading an editorial in your September issue, I thought: 'I'd like to write and tell them what a joy the SCIENTIFIC AMERICAN always is to me—most especially its editorials. And more particularly its just treatment of issues, say international prejudices, etc.' Then I thought: 'I won't trouble them, though. My continued subscription is enough.' So I let it go at that." Mrs. London has been good enough to call our attention to the voyage of the "Snark," in which Jack London and herself endeavored to circle the globe. This venture was unfortunately overlooked in a little note recently carried in our Miscellaneous Notes column. More regarding this, later. But for the present we are delighted to learn that our family of readers includes Charmian London, author of "The Log of the Snark" and "Our Hawaii," and wife of a great author.

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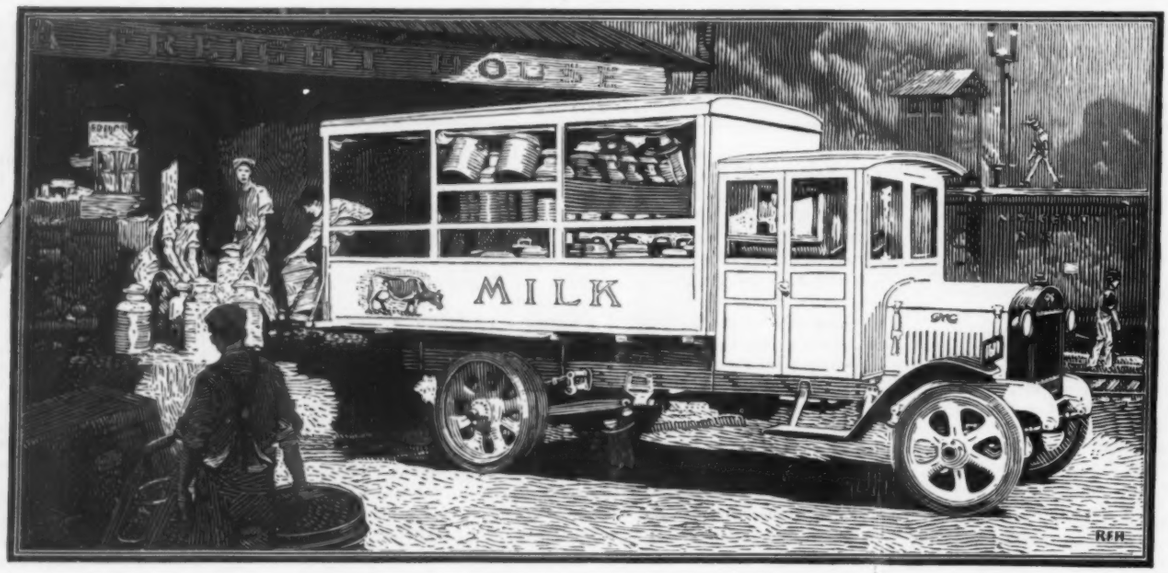

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SEVENTY-EIGHTH YEAR

SCIENTIFIC AMERICAN

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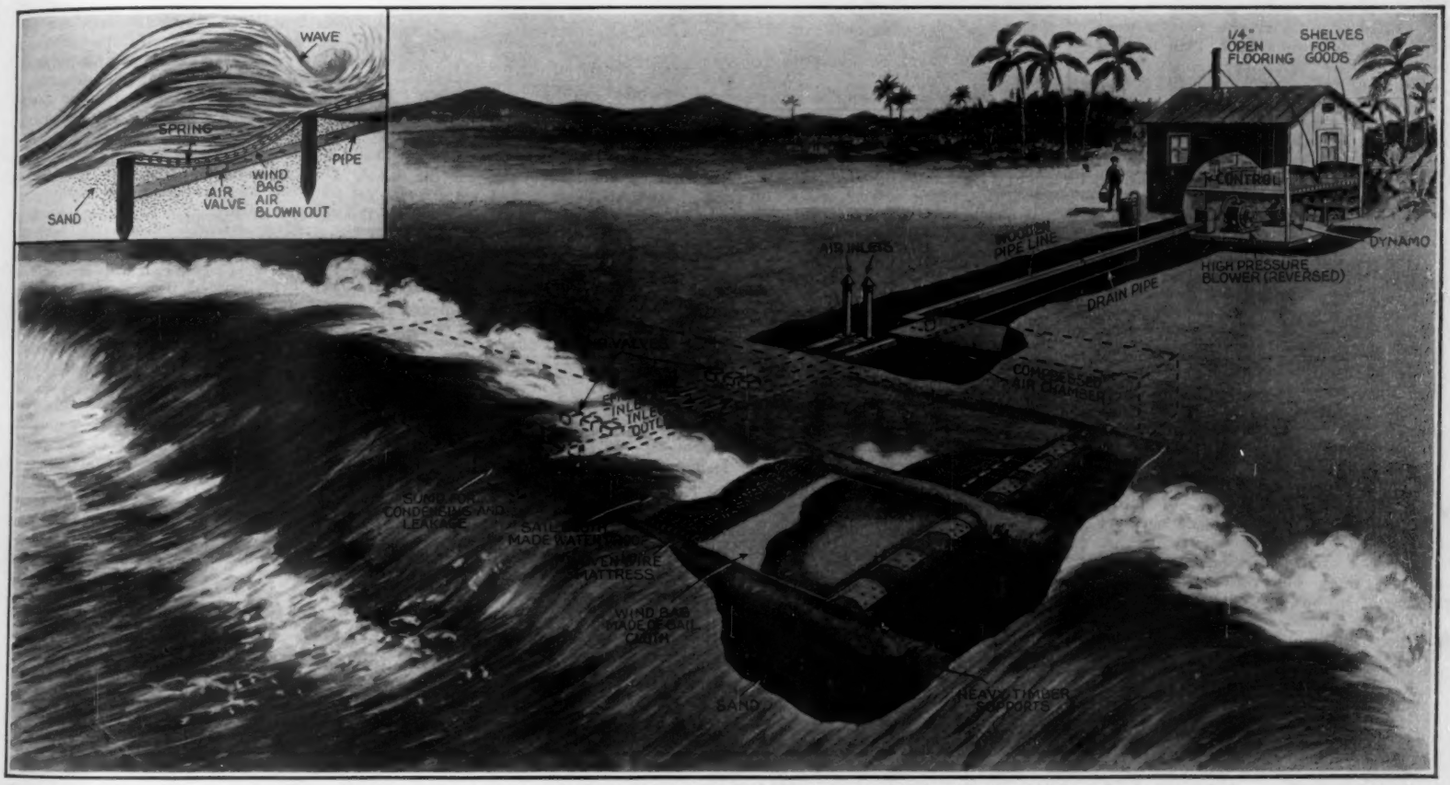
NEW YORK, OCTOBER, 1922



How an American mining engineer on the Costa Rican coast cooled and dried the air in his house, and lighted it, by utilizing the impact of the waves upon a series of extemporized canvas air bags

Where Necessity Was the Mother of Invention

WE have received from Mr. M. B. Ryan, a retired mining engineer of Milford, Connecticut, some sketches and a description of one of the most original devices for the utilization of wave power that ever came to this office; and we think our readers will agree that here is an unusual demonstration of the off-quoted saying that "necessity is the mother of invention."

Mr. Ryan tells us that during the war he was interested in a mine in Central America, and that the property was situated close to the beach at a point about 100 miles north of Punta Arenas, in Costa Rica. Because of the great heat and extreme humidity, the food supplies of the camp spoiled rapidly and Mr. Ryan cast about for some method by which he could reduce the temperature and keep the food in fairly good condition. The beach was of heavy, black manganese sand. It had a slope of about 8 to 10 degrees, and upon it there fell with ceaseless rhythm the characteristic heavy breakers of the Pacific coast. Here was a means of comparative refrigeration and also of power, if some shift could be made to utilize it. Mr. Ryan decided to make use of large deflatable air bags and utilize the weight of the waves in working these bags as a kind of huge bellows. Perhaps it would be best to let the inventor tell the story in his own words:

"I got some sail cloth and made four bags, which I made air and watertight with several coats of tar. Inlet and outlet valves consisting of heavy flaps of rubber were provided. The flaps were made from the rubber milk from Uhla trees brought in by an Indian; which gave a cheap and coarse kind of rubber. To convey the air expelled from the bags as the waves fell upon them, wooden pipes made of 2 x 12 planking and thickly tarred inside to make them airtight, were buried in the wet sand and laid from the bottom of the bags up the beach to the living quarters above high water. These large flat bags were placed in shallow depressions in the sand so that their upper surface came flush with the natural slope of the beach. To hold the bags in place, a heavy timber frame built of logs from 12 to 20 inches in diameter was built around them, as shown in the accompanying sketch, and the framing, with its bags, et cetera, was held down and secured firmly in place by being drift-bolted to short vertical piles sunk in the sand.

"It was a simple matter to expel the air from the bags by the pressure of the falling waves; but after each emptying it was necessary to inflate the bags. That was done in the following way: On the top of the timber frame, and attached to the upper sides of the bags by means of flaps sewed on, I stretched common woven-wire mattresses, arranged side by side and wired together at their edges, so as to secure the desired width to cover each bag. To protect the wire mattresses from erosion, heavily tarred canvas was laid above and attached to the spring mattresses. The pumping pits were built of such total length up and down the beach as would compensate for the rise and fall of the tide, which was from 12 to 15 feet, thereby insuring that certain of the bags would be at all times in operation."

In the original installation, the air was led through the buried wooden pipes directly into the building which served as storehouse and living quarters. But subsequently, changes were made until it took the form shown in our illustration.

To recapitulate: the system consisted of a series of deflatable canvas bags, or bellows, provided with flap valves, through which the air was discharged into buried wooden pipes for delivery to the house, while above the bags and fastened to their upper surface were tightly stretched wire mattresses which served to open out the bags and draw in air for the next discharge. There were separate pipes for the inlet of air from the atmosphere, and for the discharge of air from the bellows to the living quarters. Halfway to the house was a heavily tarred, air-tight, wooden reservoir, or compressed air chamber, which served to make the supply of air under pressure to the house more constant. From the compressed air chamber a wooden pipe line, also deeply buried, led into the cellar of the house and served to run a high-pressure blower by reversed action. By means of pulley and belt, the blower, acting as a

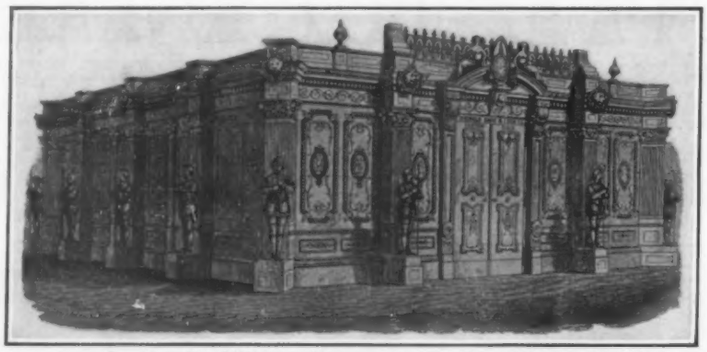
(*Continued on page 288*)

Safes and Safe-Breakers—I

The Story of the Everlasting Struggle Between the Safe Builder and the Bank Robber

By Edward H. Smith

ON a spring night in 1866 two men set out from Manhattan, crossed to Staten Island in a boat, entered a manufacturing plant at Bergen, and blew open a safe. They had brought along a special drilling apparatus, which was clamped and screwed to the floor in such a manner as to press the point of the drill against the safe door, thereby greatly reducing the labors of the burglars and expediting their operation. A small hole was bored near the handle, five ounces of ordinary rifle powder were poured in by means of a little curved funnel, and the charge was detonated with an ordinary paper-and-powder fuse. The door of the old iron strongbox was broken and thrown open by the discharge, and the intruders took what they had come for. You may read the details of the robbery in the confessions of that celebrated old outlaw, Langdon W. Moore, for he was the chief burglar.



An early bank vault which a modern yeggman would crack in a short time

The explosion fired against that old "breadbox" on that forgotten night, fifty-six years ago, was, for the purposes of this article at least, the opening shot of a battle of technical knowledge and skill which has been waged between the safe-maker and the safe-breaker ever since, and which continues in full vehemence today.

There were earlier safe burglaries by means of explosives, and the fact that Moore had invented a special drilling mechanism seems to indicate safe-blowing attempts, at least; but his is the oldest case I can find in the records and it serves admirably as a starting point for a review of the long struggle between the robbers and the makers of protective devices, since it was in the years immediately following the Civil War that nocturnal burglary, effected by chemical means, came first upon the criminal blotters. It was at this time that the great rise in mechanical and industrial invention began, and the contest of the burglar and the safe-maker is primarily a technical and inventive match.

When Skeleton Keys Were in Vogue

Before the day of Langdon Moore and the old safe on Staten Island, the technique of bank and safe burglary had experienced no vital change in generations except that due to the invention of the combination or interior locking system for safes, which was directly responsible for the employment of explosives by thieves. The old-fashioned safes, then used mainly in banks, were locked with a key and they were robbed by means of skeleton keys or by expert lock-pickers and locksmiths, with whom the burglar tribe abounded. These were the men of Dickens' day and before. They knew every kind of lock and key in existence, knew all their secrets and were generally able to penetrate the defensive mechanisms of the time without trouble. The typical bank burglary of those days was simply but adroitly managed.

The first stage of the robbery had to do with getting a line on the safe and lock. To this end it was necessary to get a member of the gang into the bank and near the safe on one pretext or another. Sometimes the burglars established themselves as locksmiths and misused information they procured when they were called to repair safes. In other instances, respectable locksmiths were corrupted by the burglars, as were the employees of banks who had access to the keys. It was, of course, always a simple matter to take a wax impression, cut a key, and wait for a favorable opportunity to use it. In many other cases the burglars simply sent one of their members into a bank to get a note changed or talk with an official on some innocent topic. While there the criminal got a look at the safe. He was generally able to recognize at a glance what type of box it was and what key would open it. If it was one of the familiar makes of safe the burglars knew that a key of a certain type would do the work, perhaps with a little filing and shaping at the time of the actual burglary.

This information having been got in advance, the burglars waited for a moonless night, broke into the bank building in the conventional manner, and used their keys on the safe lock, with the result that many an old-time banker and business man came down on the following morning and was perplexed beyond measure to discover how his money and securities had vanished from a closed and locked safe that showed no signs of tampering; for these old-time robbers took a special delight in relocking the safes they had opened, thus throwing the first suspicion upon employees of the banks.

For generations the best efforts of inventors exhausted themselves upon the devising of various complicated kinds of key locks, but the very best of these were only temporarily effective. For a time they baffled the criminals, until they were competent to discover the secrets of the new device. Then the safes flew open as before and the money vanished with alarming and perplexing regularity.

The Dawn of the Combination Lock

Finally an effort was made to devise a lock which would have no key or external locking or unlocking orifice. The combination lock came into existence then and continues in use, with its dial of numerals, three or more of which must be juxtaposed in proper sequence before the lock can be opened. As safes with this device came into general use it was felt that the burglar had been foiled at last; and so he was, for the time being, as he has been again and again in the course of his perpetual fight with the safe-maker and inventor.

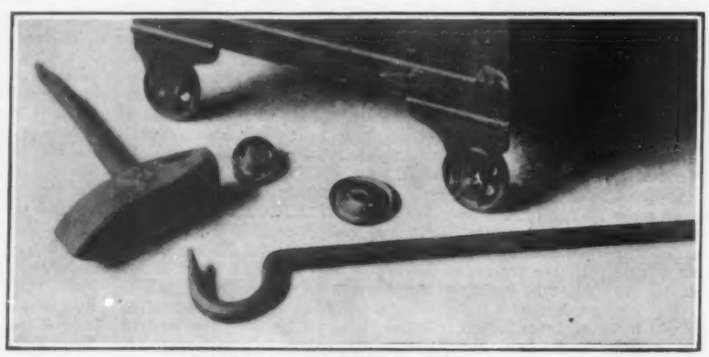
Indeed, the history of safe and bank robbery is a sequence of these repeated temporary victories over the criminal, each one soon to be followed by a fresh advantage for the burglar. The whole thing resembles a great, far-flung battle, with the tide of success ever turning from one side to the other, with victory apparently in the grasp of one contender, only to be snatched away again by the other, with defeat constantly staved off and a decision never reached. Every time the forces of law and order came forward with an invention which seemed to doom the burglar to extinction, there was a brief space of easy breathing and triumph. Then, invariably, the robber appeared with a device got from another inventor, and the joy of the respectables was at an end.

So with the combination lock. It had the old lock and key men stopped, as the phrase goes. But not for long. About the time the new safes were getting themselves generally adopted, Mr. Moore and his various fellows came forward with their drills and their rifle powder. Hence the victory was a defeat after all; a defeat upon which there rose a new epoch of criminality—the day of burglary with explosives.

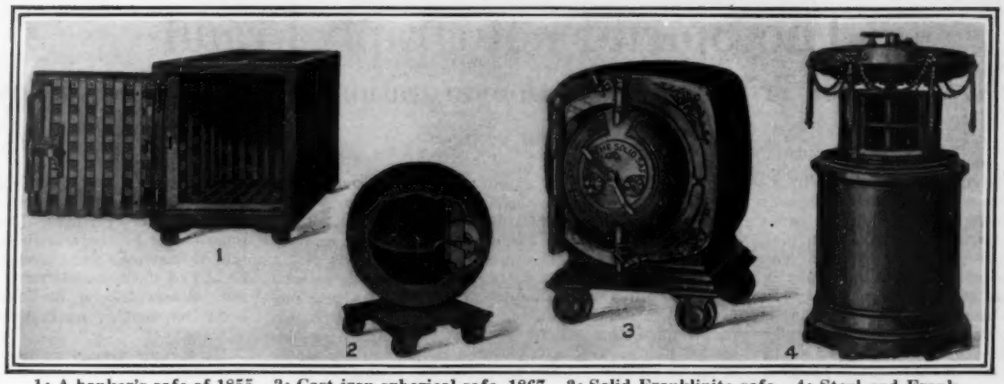
About the time the powder burglar rose in this country, another type of bank and safe robber appeared with him, also partly but not directly as a result of the combination lock—the holdup man or bandit. I mention him here because we shall see later how criminal history is made to repeat itself as a result of inventions, and because it is interesting to show how other inventions affect the careers of criminals who do not even adapt technical means to their felonious ends.

The bank bandit or stickup man of the early days is best typified in this country by Jesse and Frank James and the Younger boys, their intimates and gang members. Their method of bank robbery was simple and direct. They rode into a town on horseback, halted at the bank, leveled their revolvers and rifles at the officers, forced them to unlock the safes or hand over whatever money was in sight, and rode off, saluting with shots any of the citizenry that offered to interfere. In the Middle West of that day—soon after the Civil War—this method was tremendously effective, because there were no means of rapid intercommunication between towns and there were vast wild and unpeopled spaces, where the bandits might hide in absolute security. The Jameses had to be hunted by detachments of the military. A completely organized warfare was carried on against them, and without success. It was not until the telegraph began to web the west with its whispering strands; not until the railroad steel was

WARFARE between nations may end, or at least a truce may be effected for a period of years; but the struggle between organized society and the criminal goes on forever. And like a military campaign, the advantage swings first to one side, and then to the other. It is a battle of wits; a contest between rival inventive minds; a bitter struggle between parties endeavoring to protect their property on the one hand, and parties endeavoring to secure that which does not belong to them by any methods which they can connive. Of all the long and interesting history of criminology, the most spectacular phase, no doubt, is safe-breaking or safe-blowing. That is the phase which Mr. Edward H. Smith has selected for the first of a series of articles on criminology. Mr. Smith, by the way, has known every really prominent bank criminal in the country, beginning with Frank James and Cole Younger, and coming down to date. He is the author of numerous articles on crimes and criminals, and in our opinion the foremost authority on this broad subject. At any rate, we believe you will agree with us that our columns have never carried a more interesting yet authentic story. It is being published in two parts. The second part will appear in our November issue.—THE EDITOR.



Safe-breakers' tools that tell the story



1: A banker's safe of 1855. 2: Cast-iron spherical safe, 1867. 3: Solid Franklinite safe. 4: Steel and Franklinite cylinder safe, 1870

spun into innumerable new towns and villages; not until the wild regions were being cleared and peopled, that the old bandits were forced to retire. Inventions had forged the gyves for them, and they quit.

Yet today, after the passage of thirty-five or forty years, the bandit is coming back into existence, revived by still other inventions. We shall observe this phenomenon hereafter.

While the bandits were beginning to range the West, the powder burglars assumed in the East the mantle of the old lock and key men. Their one vital tool was the case-hardened steel drill, by means of which they were able to cut holes into the old iron and soft steel safes of the last generation with very comfortable ease. As time passed, the powder burglars spread across the country, and by the middle eighties of the last century they were operating in every State. To aid them there arose a new criminal class, whose story is the subsequent history of bank and safe robbing. I refer to the yeggs.

So much nonsense has been written about these migratory lawbreakers and so many misconceptions exist in the minds of the public, and even of the best informed police, that it is worth while here to clear up some of the errors.

The Civil War discharged more than a million soldiers upon the country in a time when industrialism was in its infancy and vast social changes were upon us. As in the case of the late war, there came a long and painful period of unemployment, with the result that many thousands of men set out for the new Western States to take up lands and establish themselves in the new communities. The stabler type found themselves. Others were not so fortunate. The lands they went to till were barren; the towns they tried to populate faltered in years of drought and flood and died where they had been born.

What Is a Yegg?

These less happy men started out to wander from place to place in search of opportunity. Vagabonding came to many of them as a new and not unpleasant experience or it continued the life of the camp and bivouac to which they had been trained. Thus the tramp class arose. Any of us who are old enough will remember that there were hundreds of thousands of these men abroad in the seventies, eighties and early nineties. The Gypsy existence of these men led naturally to petty criminality, for food that cannot be earned or begged must be stolen. And minor crimes led to major. In the end we gained a class of perpetual and criminal tramps—and from these came the yeggs.

The derivation of this term is or was obscure and has been variously attributed by students of argot and by the migratory robbers themselves. One favorite story among yeggs was that the name had come from Old John Yeagdon, an early robber of the type. But all this is mere vaporing. The term yegg is the first syllable of the German word jaeger, meaning hunter and pronounced yayger, with the long "a." The derivation becomes obvious to any student who knows the oblique meanings this word enjoys in German slang or the manner of life of the early yeggs.

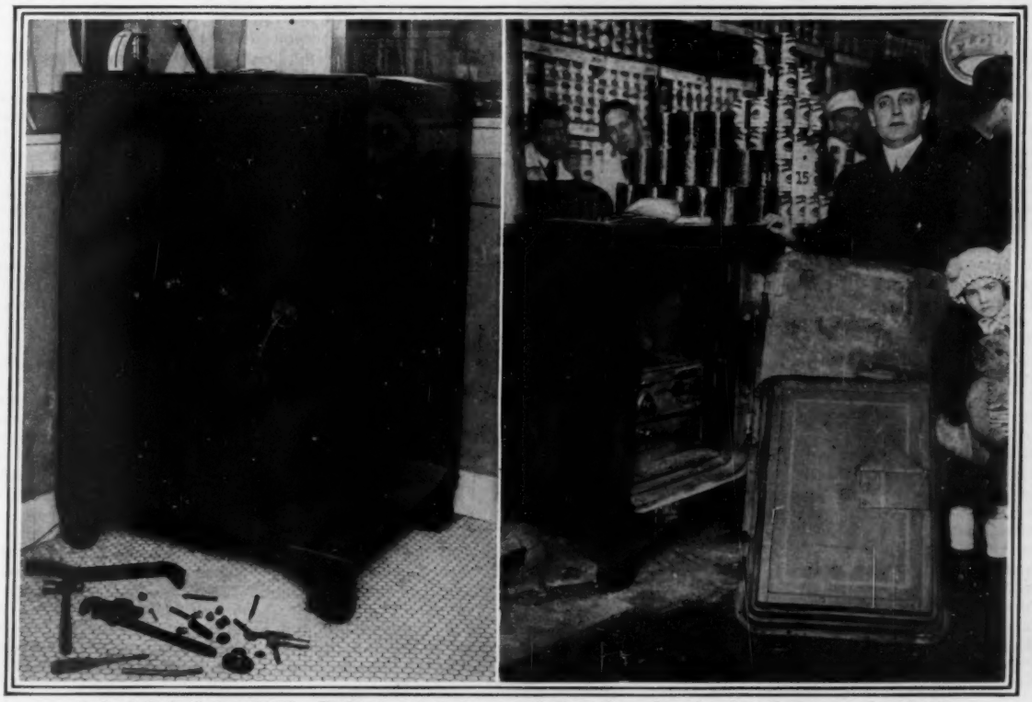
These men, contrary to police opinion, were not burglars or robbers at all, but wandering tramps who did jobs of locating for the robbers. They moved about the country constantly and had abundant opportunities to find towns where the bank or post office was in an exposed position and where the chances of blowing open the safe seemed good. The yegg did no more than make notes regarding these safes and towns. Later he met gangs of safe-breakers in his travels and turned over his information on the basis of a percentage of the loot. The burglars went where the yegg sent them and later turned over to him various sums of money, according to the prosperity of their business.

In time yegging came to be a profession and a considerable number of shrewd tramps did nothing else. By contacts with the burglar crews they learned a good deal of the technical side of safe-making and safe-breaking, with the result that they were then able to give their confederates more accurate data concerning the "marks" they had "located." As an example of what the burglars wanted most to know, there is the detail of the lock structure in old-fashioned safes. The yegg divided all safes of that day into two kinds, front lockers and back lockers. The former were safes in which the locking mechanism was located between the front steel casing and the rear casing of the outer door. Back lockers, on the other hand, were safes in which the locks were buried behind the inner layer of steel, *i.e.*, on the back of the safe door. Front lockers were easier to blow open because the burglar needed to drill only through the outer shell. For the back lockers he had to have long drills, to reach through the entire thickness of the door and attack its rear shell or wall. They were not only more cumbersome, but they required two or three times as much time for the drilling, an important matter to the burglar.

For the reader who knows nothing of safe structure it should be explained here that all the old safes were constructed with a view of fireproofing. The door of such a safe was really a can of thick sheet iron or steel, hollow in between and usually filled with what is called a packing. Originally all packings were of plaster of paris or some similar material, occasionally compounded with asbestos to add to the heat resistance. Originally all the locks were inside this shell, but when the powder burglar began to attack these safes the first move against him was the retirement of the locking system behind the inner sheet of steel. We shall see a good deal more of burglar-proofing devices later. Meantime, to finish with the yeggs.

As the safe-blower gangs became better organized and more efficient, the found that they could not depend upon the haphazard reports of the old yeggs, and organized information departments of their own. In this way the yegg became a member of the burglar gang and frequently its leader. Later on, when the police came to know a little about the methods of the safe blowers and kept a sharp lookout for snooping yeggs, the gangs changed their information or scouting departments and placed this responsible work mainly into the hands of young boys, called cat kids, bronks or broncbos. These were boys who had run away from home to see the world, been picked up by tramps and finally turned over to the burglars, by whom they were educated to do the yegg's work. The boys grew up and became graduate burglars. Thus the new gangs were recruited, when the reinforcements were not taken from those vastest of all crime schools, the prisons.

The police, not understanding the methods of the criminals, confounded the yegg and the safe blower from the beginning and quite naturally applied the colorful and brief name of the locater tramp to the whole gang. Later, when the gangs carried their own yeggs, the term was fortified in its application and the yegg, who had been nothing except what the German word implies, a hunter and ranger, came to be a safe blower of a certain type. Thus the term was made to mean any safe blower who wandered about the country, traveling mainly on freight trains and living a good deal like a tramp. Still more recently, because of important changes in the habits of these robbers, yegg had come to mean any safe blower, without reference to his manner of living. It is surprising how little the police know about criminal life in general.



Left: A Safe that resisted. *Right:* A safe that succumbed to nitro-glycerine, but the strong chest held

When Old-Time Safes Met Irresistible Black Powder

As these powder-using yeggs became numerous and the old fireproof safes began popping open all over the country, yielding gluts of money and securities, the attention of safe-makers veered to the burglar-proof idea. First came the back locker safe, but it was not burglar proof. Then came various experiments with the packing of safes. The manufacturers knew that burglars managed their feats by drilling holes into the doors of safes, digging away a little of the packing and pouring in a few ounces of powder from a hollow, tapered cow's horn. They calculated that this might be prevented by the use of other kinds of packing. One device was the employment of loose sand, on the theory that it would filter down and block up any hole the bur-

(*Cont. on page 283*)

The Spirit-Photograph Fraud

The Evidence of Trickery, and a Demonstration of the Tricks Employed

By James Black

THE history of spirit photography is interesting and remarkable. In this branch of psychic phenomena there is the same long record of fraud and imposition that is to be found in every other branch. The earliest record of psychic photography is that of W. H. Mumler, who in 1861 established a psychic studio in Boston. One of his dupes found out that a living sitter posed for one of the spirits and Mumler was laughed out of business. He bobbed up again in New York in 1869, and after doing a good business for a short time was prosecuted for obtaining money by fraudulent means. Although discharged for lack of sufficient evidence he was entirely discredited and dropped from view. A few years later two well-known English mediums, Mr. and Mrs. Guppy, with the assistance of a professional photographer, started in the business. The work was of very poor order, the negatives frequently showed signs of having been tampered with, and clear signs of very crude double exposure were to be seen. They were proved to be fakers and soon gave up the business.

Buguet, a Frenchman, visited England in 1875 and turned out some very good spirit pictures. He had a much higher degree of photographic skill than his predecessors, and had several assistants who, with a collection of lay figures, provided the spirits. This man's work was considered quite genuine and reliable by many noted spiritists, and the Rev. Stainton Moses—well known in spirit circles—was his stout supporter. Buguet returned to France and, a few months after Mr. Moses had been at such pains to prove him and his works genuine, was arrested in France, and charged by the French Government with fraudulent practices in the manufacture of spirit pictures. When on trial he made a complete confession, admitting that assistants and double exposures provided his dupes with the spooks. The Buguet exposure put a period to spirit photography for a long time, little being heard of it till about 1900, when it began to take a new lease of life, and during the last twenty years it has slowly entrenched itself as one of the "truly genuine" of the many psychic phenomena.

After such clear proof of fraud as was offered in the Buguet case one wonders that anyone could retain faith in him. But the will to believe moves mountains. Mr. Moses, in commenting on the case, stated that the judge was prejudiced, and that Buguet was without doubt a genuine medium who had been bribed to make a spurious confession. In support of his contention he called attention to a spirit that had been recognized by one witness as the picture of a dead friend; but he omitted to mention that this same spirit had been recognized by another equally credible witness as the picture of a relative who was very much alive!

Before passing on to a consideration of the claims of the modern spirit photographers to authenticity it is interesting to note how difficult it is to harmonize the reality of spirit pictures with the "ectoplasm" theory of the origin of spirits, dealt with by the present writer in the September number of this journal. This theory is that all spirits are built up of ectoplasmic extrudations from the medium, and this ectoplasm is visible to medium and spiritist alike. Yet the spirits who call to be snapped are remarkable for their lack of visibility. Neither the medium nor spiritist sees them, or is sure of their presence till the plate is developed. Again, the photographer does not control the spirits; they very conveniently happen in of their own volition. It is the photographic plates that the mediums control—in fact we shall show that they have entirely too much control of the plates! But what is really very odd is the fact that the uncontrolled spirits who drop down to this work-a-day world to have their pictures taken never by any chance call at the first studio they happen on. Not at all—they seek out those controlled plates. One well-known medium gravely states a spirit picture cannot be taken on a film, or in a hand camera, then another one goes out entirely alone and gets spooks on films in a hand camera!

Now let us see if the modern spook-snapper is any more worthy of credence than earlier operators. In this connection it will be fair to consider three of the leading exponents: William Hope, who is considered by Sir Arthur Conan Doyle as "the leading psychic photographer of Great Britain"; Mr. Vearncombe; and Mrs. Deane. These photographers should be genuine, for they have the approval of the British College of Psychic Science—an institution teaching the reality and truth of spiritualism and its phenomena. As the college acts as booking agent for these mediums, they should be beyond reproach.

MR. BLACK bases his attack upon spirit photography upon two counts: the proved fraud that stands on the records against all the spirit photographers, and his own ability, out of a very modest photographic skill, to produce by trickery all of the spirit photographer's results. The adjoining print is a case in point. As a matter of convenience, and in some degree also a measure of proof that the print is a trick one as claimed by Mr. Black, the same lady is used as the "sitter" and as the "spirit." The plate has been exposed three times—first to the well-defined "spirit" at the upper left, second to the ghost-like "spirit" at the right, and finally to the "sitter." It will be especially noted that none of the exposures is the least bit uncertain in its results by virtue of the other exposures before or after it. The dimness—"partial materialization," if you please—of the second "ghost" is a studied effect, produced by moving the camera. These "spirits" Mr. Black presents as easily equal to anything produced by the tribe of spirit photographers, and as evidence that their results need not be taken seriously.—THE EDITOR.

The Society for Psychic Research (British) tried for years to get a test sitting with William Hope, but he shunned investigation. Mr. Marriott, a London photographic expert, asked Hope for a test sitting, but was refused. He then challenged Hope to produce a spirit message or picture under conditions that would prevent fraud, but the medium would not perform. Sir Arthur Conan Doyle, however, assured all and sundry that the man was all right, for he had watched him work and fraud was not possible in the way the pictures were produced. Then Mr. Marriott offered to produce for Doyle spook pictures in the same circumstances in which Hope worked. This offer was accepted and the test took place at the British College. Sir Arthur and four other observers were present. Mr. Marriott and his apparatus were subjected to the closest scrutiny, and his actions watched carefully, but all agreed no fraudulent methods were observed. When the plates were developed two "spirit extras" appeared. If failure to see the trickery is a proof of genuine spirit pictures then these by Mr. Marriott must surely be the real thing. But it was frankly admitted that they were produced by trickery not noticed by any of the five observers. It is clear that Hope cannot be accepted on Sir Arthur's assurance of fraud being impossible; he is shown to be an incompetent witness.

Hope came very prominently before the public some few years ago on account of a spirit picture of the late William Ewart Gladstone which he took for the Rev. Mr. Walker Wynn. When this was exhibited by its owner it was noted that the print showed very plainly the screen marks always associated with the half-tone illustration. This, of course, does not prove Hope a faker; for Mr. Gladstone may have been occupied with spookish matters of state and sent an ectoplasmic half-tone to be photographed in his stead. And then again, he may not.

Mr. Edward Bush, a member of the S. P. R. (British) arranged a seance with Hope and sent him a photograph of a man Hope presumed to be dead. At the first sitting a spirit message came through, the second produced a spirit picture of the subject of this photograph. This is doubly remarkable; the subject was the son-in-law of Mr. Bush, who was alive and well! The message received was in the same handwriting as that of numerous other messages received through the same agency, and carried the same error in spelling too. The message has been *admitted to be a forgery;* but Hope and his adherents still insist that *the picture is quite genuine!* The psychic scientist's ability to dissociate any portion of his work from any other portion is far from being the least of his assets.

Positive proof that Hope is nothing but an unscrupulous rascal is afforded by the experience of Mr. Price, another member of the S. P. R. who investigated Hope in February last. Mr. Price had sought a seance with Hope for five years and at last one was arranged for him through the agency of the British College of Psychic Science. The conditions were that a fee of two guineas (about $10) be paid and a packet of six quarter plates be provided. To make sure that he was not tricked Mr. Price consulted with The Imperial Dry Plate Company, Limited, of London. They provided him with a special half-dozen plates upon which a design had been stencilled by X-rays Mr. Price went to the college and was introduced to Hope and his assistant, Mrs. Buxton, who asked if the plates had been tampered with; the ingenuously truthful reply was "They are in exactly the same condition as when received from the maker." This was satisfactory to the mediums.

The seance commenced by the company seating themselves around a table. Mrs. Buxton led by singing a hymn; Hope then delivered himself of a long extempore prayer, concluding by invoking the aid of the Almighty to get in touch with the spirits of the departed. There were more hymns and prayers, the service concluding by the recitation of the Lord's Prayer. Fraud would not ordinarily be associated with such a religious atmosphere.

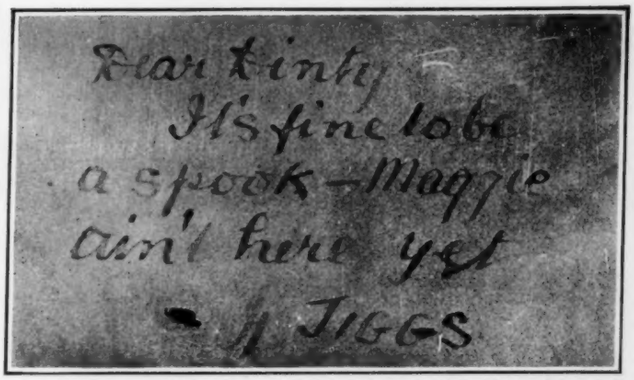
Hope then brought the dark slide to Mr. Price so that he might examine it, and during this examination he marked it so that he would be sure that it was the one that was used in the camera. The two men then went into the dark room and Mr. Price opened the packet of plates and, under Hope's instructions, loaded the marked slide. When this was done Hope asked Mr. Price to pack up the unused plates, at the same time

taking the loaded slide from him. Whilst packing up the plates Mr. Price states he never once lost sight of the slide or Hope's hands. He noticed him take a half turn from the light and quickly put the slide in his breast pocket and remove another one. When the repacking was finished a loaded slide was returned and the two went to the door of the dark room; before leaving, Hope asked Price if he would like to mark the plates in any way, to assure himself that no trickery was taking place. This was not done—there was no need! They immediately returned to the studio, and before handing the slide to Hope Mr. Price looked for the marks he had placed on the slide he had loaded. Of course, they were not there. No mention was made to Hope that the substitution of slides had been noted.

Mr. Price took his seat before the camera, the plates were exposed and in due time developed. When they were developing, Mr. Price had further proof of the change. The plates furnished were for flashlight work, and when developing should have flashed up black at once; they developed slowly, just as the ordinary plate does. One plate showed a spirit extra of a lady and the other simply a photograph of Mr. Price; neither had any trace of the design stencilled on by the X-rays. The rules of the college do not permit spirit negatives to be taken away, but the other negative Mr. Price retained. Immediately after the sitting the remaining four plates were taken to a professional photographer to develop; the X-ray design appeared on each of them. When the negative retained by Mr. Price was compared with those remaining of the original half-dozen it was seen that it was of glass of a different thickness and color. This completes the chain of evidence proving William Hope, "the leading psychic photographer of Great Britain," to be a common cheat who obtains money under false pretences; yet he still stands high in the estimation of spiritists and of the British College.

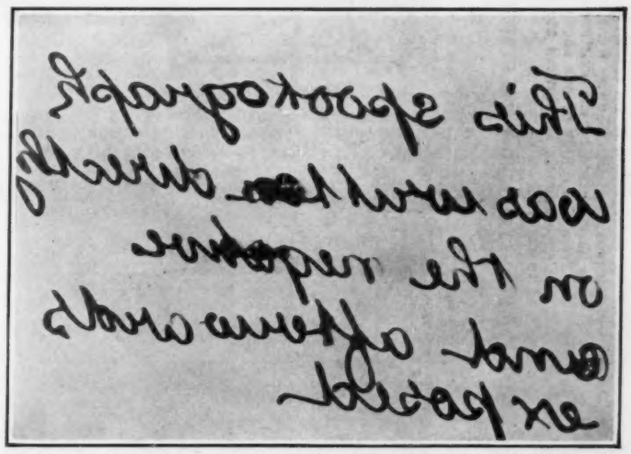
Mr. Vearncombe is a different type of medium from Hope. His specialty is getting spirit extras on plates without either opening the packet, or exposing the plates in any way. He also photographs objects belonging to clients and gets spirit extras on these plates. The Occult Committee of "The Magic Circle," a magicians' organization, investigated this gentleman. The first test was to prove the spirit extra on unopened plates. They sent him a package of plates enclosed in a sealed lead wrapper (lead being opaque to X-rays), and a request for a message or picture. The package was "controlled" by Vearncombe and returned; when developed the plates were all blank. The limits of his psychic powers seem to coincide with the limits of the X-rays. Another packet of plates was sent to him, and fourteen traps set to disclose any tampering that might take place whilst under "control." When these plates were returned one disclosed a spirit extra on development; but unfortunately Vearncombe had fallen into twelve of the fourteen traps set to catch his trickery. One of these was the placing of a slip of paper at the top of the packet, slightly gluing it to the inside wrapper. This slip was found at the bottom of the packet. Another was the painting of the top left-hand edge of the plates with red varnish, which would be invisible in the dark room. Examination showed that three of the plates had been reversed, the red line showing at the bottom right-hand edge. Vearncombe was informed that the experiment had resulted in a spirit extra appearing, and was asked for an assurance that the package had not been tampered with in any way. He replied, assuring the experimenters that the plates had been "controlled," but had neither been opened nor exposed! This disposes of Mr. Vearncombe; he is a liar as well as a fraud.

The British College has so much faith in Mrs. Deane that arrangements have been made with her to give considerably reduced rates to college members who attend her sittings. Mrs. Deane usually requires a packet of plates to be sent to her for control several days before the sitting takes place. The Magic Circle Committee sent her one packet, and after the sitting several plates developed spirit faces and "spirit lights." The precautions taken



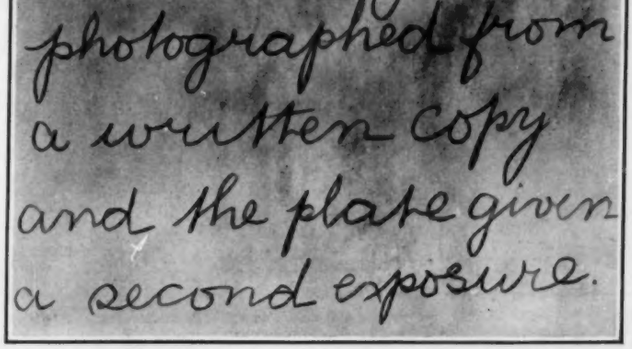
Of the three "spirit messages" produced by Mr. Black by three different tricks and reproduced on this page, this one, from the hero of "Bringing Up Father" to his beloved pal, Dinty, was imprinted upon the plates of an unopened packet by means of X-rays

showed that the packet had been tampered with before the seance. After this experience the committee made an application to the college for a test sitting and this was granted. Plates were provided for the use of the medium, and four slides were loaded. While in the dark room Mrs. Deane reached for her hymn book, and



This "spookograph" was written directly on the plate with tartaric acid, the plate thus prepared being then substituted for the sitter's test plate and given an exposure in regular course. The emulsion is destroyed by the acid, hence the message appears as part of the negative

whilst so doing was seen to change one of the slides. Whilst the slides were being loaded the experimenter, by means of a small chemical, had imprinted the sign of the Magic Circle upon each of the plates. When the plates were exposed and developed one spirit picture appeared on a plate, but it had no Magic Circle sign upon it—the three others developed nothing but



As its text indicates, this message was got on to the plate by ordinary double exposure of the sort used in the case of the spirit photographs

the sign placed upon them by the experimenter. One substituted plate—one spook: this appears to be the psychic proportion.

After the sitting the committee informed the college authorities that they had proof that Mrs. Deane was using fraudulent methods in the production of her spirits, and that they were unquestionably produced on previously prepared plates which were substituted for the test plates. Mr. Hewat McKenzie, the principal, promptly wrote Mr. E. H. Clarke, chairman of the Magic Circle Committee, as follows: "I am not prepared to grant any member of the Magic Circle any further sittings with our mediums." Proof of fraud appears to be of small moment to the college, just so they still have their mediums.

In Hope's case frantic efforts have been made to refute the evidence—but without success. Mr. McKenzie suggested that a committee, formed of members of his college, the Society for Psychic Research, and the Society of Supernormal Pictures, be detailed to investigate and report. The Society for Psychic Research declined to have anything to do with the matter, as they consider no useful purpose would be served by so doing. Years ago the S. P. R. decided that when satisfactory evidence was produced that a medium used fraudulent means to produce phenomena, neither time nor effort would be taken in further investigation of such medium.

The foregoing tests clearly establish that spirit messages and pictures are produced on plates specially prepared for the purpose, an exposure having been made unknown to the sitter. It only remains to tell how the spook-snappers work their little tricks. The written messages may in fact be produced in several ways. A simple method is to write directly upon the plate with a chemical solution that will destroy the emulsion—tartaric acid is one such; the subsequent exposure in the presence of the sitter has then no effect on the part written upon. In this way the strange messages written backwards upon the print are produced. Sometimes the print is made with the negative reversed, then the writing is not very sharp. An examination of the negative enables the investigator of experience to detect this method quite easily.

Mr. Bush, in his experience with Hope, saw the spirit writing put upon the plate by means of a specially constructed flashlight, with the message written upon the lens. A suitable opportunity is taken to press the apparatus against the plate whilst in the dark room and the "spookograph" is ready. Mr. Bush made one of these special flashlights and found it worked very well. Another, and more used method, is to write a message and photograph it with the exposure so timed as to permit a second exposure. The prepared plate is then substituted for the test plate, exposed, and once again the spirits have communicated.

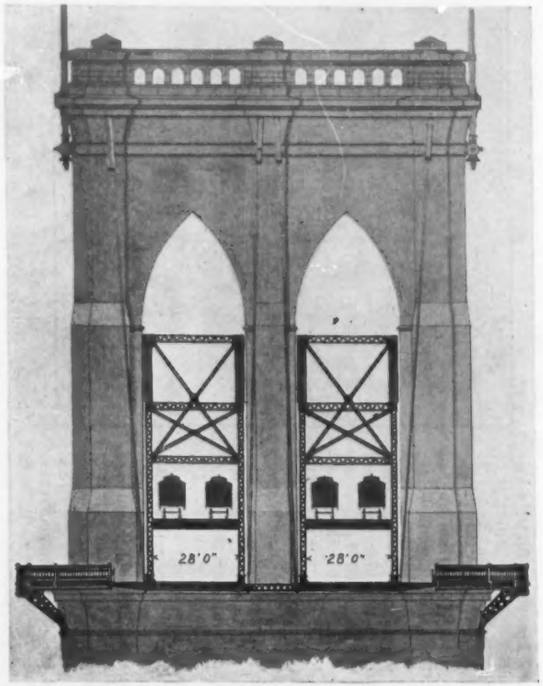
Spirit messages are sometimes made with X-rays. The writing is done with a solution of metallic salts—acetate of lead is usually used—and a short exposure is given—say, one-tenth second at a distance of 30 inches. Some fakers have a small outfit that enables them to do the work right under the noses of the sitters. The hymn singing or phonograph playing that always goes with a sitting will disguise the slight noise made by the exposure. Sometimes X-rays are used to get messages on unopened packets of plates. The writer so treated a packet and sent it to a professional photographer to be developed. The photographer expected to get blank plates and was considerably surprised when he received a message for Dinty Moore, from his old friend Jiggs, of the familiar comic-strip series "Bringing Up Father." Subsequent investigation casts doubt on the authenticity of this message; according to Mr. McManus—who should know—Jiggs at the time of writing is here with us and having one of his periodic difficulties with Maggie.

The production of a good spirit picture calls for a higher degree of photographic skill than is required for written messages. Some of the early pictures were crudely faked prints; in this case two negatives are required, one for the spirit and one for the sitter, and both are used to get the spirit print. This work would deceive only the very foolish, for most

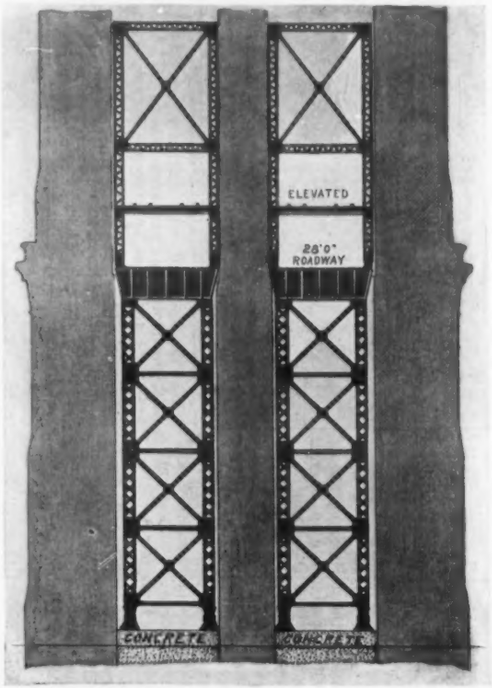
(Continued on page 286)

In 1903 plans were drawn by the Bridge Commissioner for the strengthening of the Brooklyn Bridge and the enlargement of its carrying capacity. The plans included the widening of the floor and its entire reconstruction on modern lines. The network of diagonal cables, running from the tops of the towers to the trusses of the roadway were to be removed, since they are unnecessary, introduce uncertainty in estimating the stresses in the bridge, and add to the dead load. The carrying capacity of the bridge was to be increased by the construction of four lines of trusses, extending throughout the whole length of the bridge from anchorage to anchorage. These trusses form continuous cantilevers, reaching unbroken from the center of one shore span to the center of the shore span on the opposite side, the ends of these trusses being held down by anchor piers. Short cantilever trusses extend from these points to the anchorages. The towers are heightened by crowning them with the parapet which they were originally designed to carry

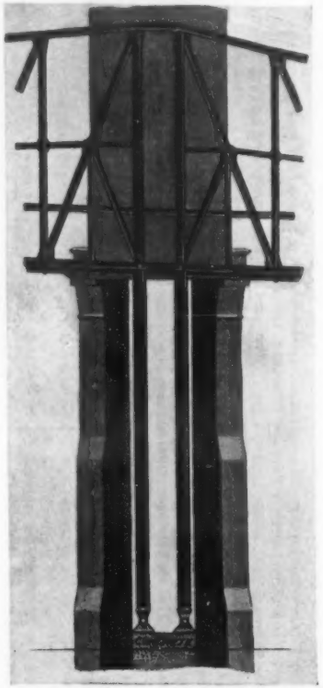
BROOKLYN BRIDGE AS IT WOULD APPEAR WHEN RECONSTRUCTED WITH STRENGTHENING TRUSSES



End view of tower, showing the new trusses filling the full width of the tower openings, the passenger walks around tower, and the new coping



Transverse section through tower, showing the braced steel piers by which the load of the trusses is carried down to the base of tower



Longitudinal section of tower. Note how trusses are carried by steel piers placed within hollow tower

Anchor pier at center of side span to which inshore ends of main cantilevers are anchored

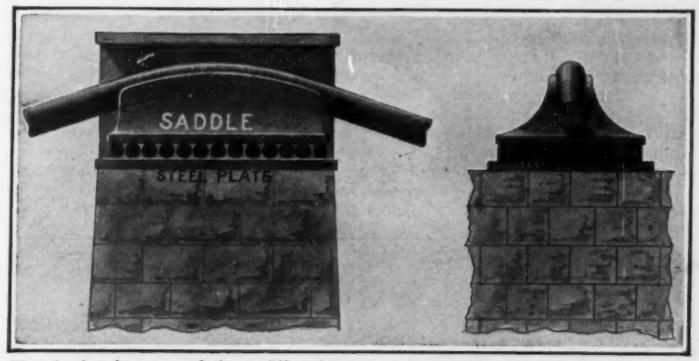
DETAILS OF THE STRENGTHENING TRUSSES, SHOWING HOW THEIR WEIGHT WILL BE TRANSFERRED DIRECTLY TO THE BASE OF THE TOWERS.

Building a Bridge Within a Bridge

A Plan for Strengthening the Brooklyn Bridge and Enlarging Its Carrying Capacity

IN 1903, shortly before the close of the Mayor Low Administration, the Commissioner of Bridges, Gustav Lindenthal, sent to the Mayor a report embodying his proposals for the repair of the Brooklyn Bridge and a considerable enlargement of its carrying capacity. We present herewith a full digest of this report, together with a set of drawings which are based upon those which accompanied the original document dated December 23, 1903.

Under the ridiculous system by which the city is governed, in which too often the plans of a previous administration are discredited, simply on the ground that they were drawn up under that administration, this report of the Bridge Commissioner has lain buried for nearly twenty years in the archives of the Bridge Department, and was not even mentioned by the present Bridge Commissioner during the recent discussion of the Brooklyn Bridge. The plan of reconstruction is brilliant in conception and would be perfectly feasible to carry out. Moreover, it would practically double the capacity of the bridge for about one-fourth of the cost of a new bridge. Despite the fact that it was drawn up by one of the leading bridge engineers of the world, the Commissioner makes no reference whatever to this plan, and he blithely talks about the building of a new bridge to cost $40,000,000. The politicians of the present day are never so happy as when spending the public funds, and it is for the citizens to decide if they wish to build a new bridge before the existing bridge has been reconstructed and enlarged according to the plans herewith presented.



Sketch showing one of the saddles for supporting cables at the top of towers. It consists of a casting with a half-round pocket in which the cable is seated and a flat, machined base which rests upon a set of rollers. These rollers were neglected and became rusted immovably in place. Recently, due to an accumulation of load on the center span, the cables shifted in the saddles to the extent of an inch or two

Mr. Lindenthal's plans of 1903 proposed to convert the present old structure with one deck into a new structure with two decks, arranged to accommodate four elevated tracks on the upper deck, and two 28-foot roadways for motor traffic on the lower deck. As the present roadways have a clear space of only 9 feet, it would be seen that the proposed reconstruction will more than treble the existing roadway capacity. The accompanying plans show the plans for rebuilding. They comprise not only the rebuilding of the superstructure, but also the enlargement of the anchorages which otherwise would be too light. It is intended to place stairways and elevators at each anchorage, to make the bridge accessible from the street below. The stone towers would be somewhat heightened, in order to provide a roof for the masonry, and to make the cable bearings more accessible for inspection. At present the top of the towers is accessible only with great difficulty, and not without danger.

The roadways will be fireproof, built with steel channel foundations, with asphaltic paving. Throughout, the structure is intended to be modernized and brought up to a condition where its maintenance, which is now very costly, may be reduced (possibly by one-half) and confined merely to the painting of the iron-work and the repair of the tracks and pavement. The present structure has a capacity of two elevated tracks, two trolley tracks, two narrow strips of less than 9 feet each, on each roadway, for truck traffic, and one promenade 15 feet in width. The live load for which the bridge was originally designed was about 2000 pounds per linear foot.

The present width of the bridge is 82 feet, the width of the reconstructed bridge will be 105 feet, and its carrying capacity will be 11,000 pounds per linear foot, or over five times greater than for the old bridge.

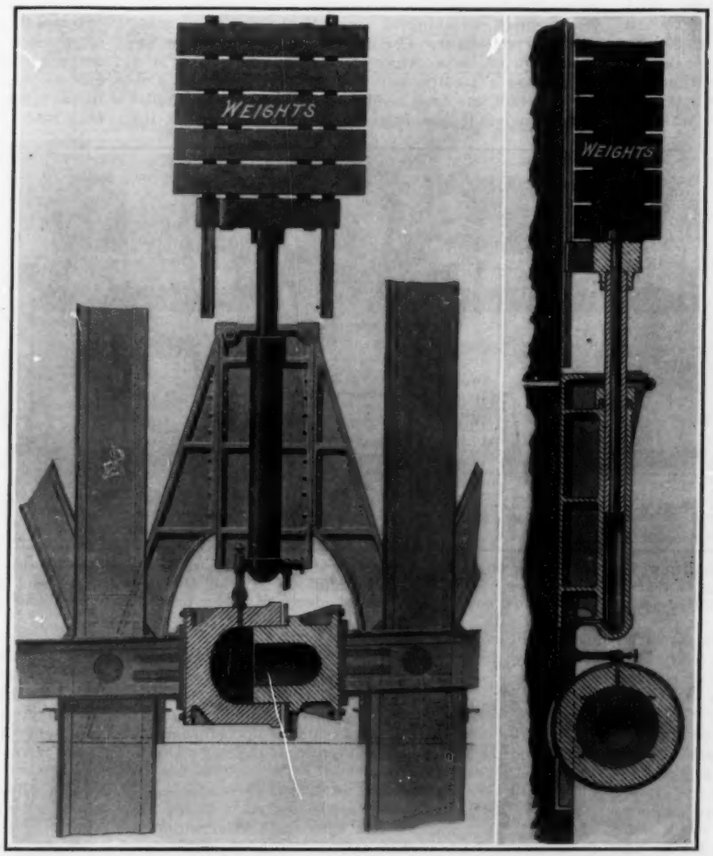
The leading considerations in the laying out of the plan were:

1. No additional cables shall be required and no additional load shall be imposed upon the present cables.
2. No additional load shall be put upon the top of the towers which would bring a higher pressure upon the masonry than would be considered prudent.
3. The bridge shall be safe under a congested maximum live load wherever it may occur on it between the anchorages. The existing bridge has not been designed for that condition, and would not be safe if a local congestion should occur on it anywhere between anchorages.
4. The weight of the new stiffening trusses shall not be carried by the cables, for this would considerably increase the strain in the latter and reduce the stability of the anchorages.
5. The cables shall carry practically the entire live load and also the weight of the floor construction proper.
6. The stiffening trusses shall carry their own weight and that of the wind and lateral bracing.
7. In order to make this distribution of dead and live load upon the cables and the stiffening trusses an absolute certainty, the stiffening trusses shall be designed as continuous trusses through the towers, with fixed pier bending moments to be described hereafter.
8. Anchor posts will be placed under the middle of each end span. They will act as anchors for the continuous girders of the middle span, and as supports for the live load on the side spans. The expansion joints necessary for temperature changes will be placed near those anchor posts.

In order to keep the dead weight of the new structure within the lowest practicable limits, nickel steel has been selected for the stiffening trusses.

The stays of wire ropes running over the top of the towers to the present stiffening trusses will be removed, being a troublesome feature and placing a useless weight on top of the towers. The present wind wire ropes will also be removed. The new trusses and their lateral bracing will effectively sustain any possible wind pressure.

It is desired to use the present suspenders from the cable and to maintain the cables in an inclined or cradled position. The bands around the cables will be replaced with wider ones of cast steel. Each two suspenders—7½ feet apart—shall be connected by a cross connection at their lower ends, to be attached to the floor beams, 15 feet apart. The panels of the stiffening trusses have been divided with that view into lengths of 30 feet each, with two subpanels of 15 feet. The height of the continuous stiffening trusses will be 75 feet at each tower, reducing to 19 feet at center of main span and at anchor posts.



Bottom chord of auxiliary trusses at tower, showing the hydraulic equalizer, placed between the abutting ends of the lower chords. By the adjustment of the weights on the accumulator, it is possible to prevent these chords (and therefore the auxiliary trusses) from being loaded beyond a predetermined limit. Should this load be exceeded on center or side spans, the trusses begin to depress, transferring the excess load to the main cables

The constant pier-bending moments at the towers in the stiffening trusses will be produced by a hydraulic piston arrangement between the ends of the bottom chords, which will be in compression. The pressure at this point will be maintained constant. The calculation of the strains in the stiffening trusses thereby becomes much simplified. The stiffening trusses being low in height at the center of the middle span, can bend under temperature changes sufficiently up and down without causing considerable strains in the chords.

The weight of the stiffening trusses at the towers is carried down by steel posts inside the hollow space in the existing stone towers directly to the tower foundations, which are amply strong to take this load.

The occurrence of the full congested load upon the bridge will be an extremely rare event; and for that reason high-unit stresses, within 10 per cent of the elastic limit in the stiffening girders, can be safely assumed.

The design is so laid out that the bridge can be reconstructed without much disturbance of the traffic over it.

The anchorages require lengthening to increase the resistance to sliding and to prevent a large increase in the present toe pressure from the increased pull upon the cable.

The foundation upon which the anchorages stand is on both sides a fine, compact sand, and so far has proved to be stable and satisfactory. But in order to be quite safe, steel sheet piling should be driven all around the foundation of each anchorage, to protect the same against injury

from excavation that may be done in the future in its neighborhood, either for the construction of houses, sewers, or water pipes.

GUSTAV LINDENTHAL,
Commissioner of Bridges.

December 23, 1903.

[The total cost of the improvements outlined in the above report, at present prices, would be about $10,000,000; but for this sum the city would secure a practically new bridge, of much greater capacity, perfectly stable, and, with proper maintenance, good for a thousand years of life.—EDITOR.]

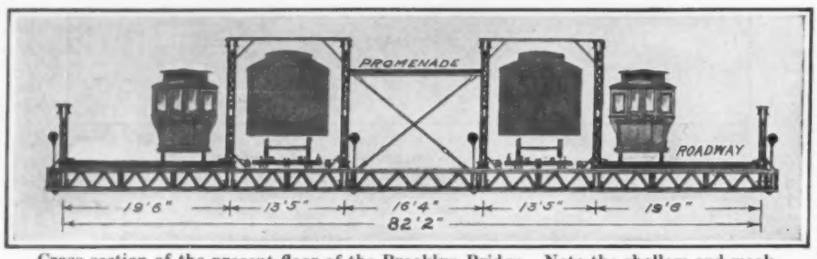
Colloidal Metals That Cure Human Ills

PROBABLY the most familiar of all metallic drugs, whether in colloidal or other forms, is colloidal silver. Almost every household has today in its medicine closet a bottle of argyrol, a colloidal silver albuminoid. Colloidal silver itself is a cherry-red liquid. It has been used as a drug, with marked success so it is claimed, in the treatment of tonsilitis, acne (pimply face and body), various skin diseases and eruptions on the body. It has been injected in the veins of persons suffering from bronchial troubles and pneumonia. Dysentery and other intestinal troubles have yielded to treatment with this drug. The eye doctors have used it in treating various diseases of the eye, infections and burns, as well as wounds of the cornea. Quite contrary to the ordinary silver drugs, it does not cause pain nor discoloration of the skin. It does not irritate but soothes. It will cause an inflammation to subside and can be used very effectively in removing warts. It has replaced silver nitrate in ocular medicine to a large extent. Tests that have been made with this drug have proved it to be very effective against disease germs and bacteria, possessing about the same potency as corrosive sublimate, but with no toxic effect on the patient. A certain preparation of colloidal silver, which is opaque to the X-rays, has been found very useful in the diagnosis of certain diseases.

Colloidal mercury is also a well-known drug. The various salts of mercury that are used as medicine are very peculiar in their action. When they are very soluble in the fluids of the body, then they are extremely poisonous; when they are not rapidly soluble, they are very insoluble, so that their action is very slow. The best example of this is in the case of calomel, which is the very insoluble mercury chloride, while corrosive sublimate, the very soluble chloride, is extremely toxic. The toxic chloride is well known for its antiseptic properties. Colloidal mercury is very quick in its action, but its toxicity is so low that two teaspoonfuls of a 1 in 2000 solution can be taken twice daily without any bad effects. The drug has been used with claimed success in the treatment of relapsing malaria and syphilis.

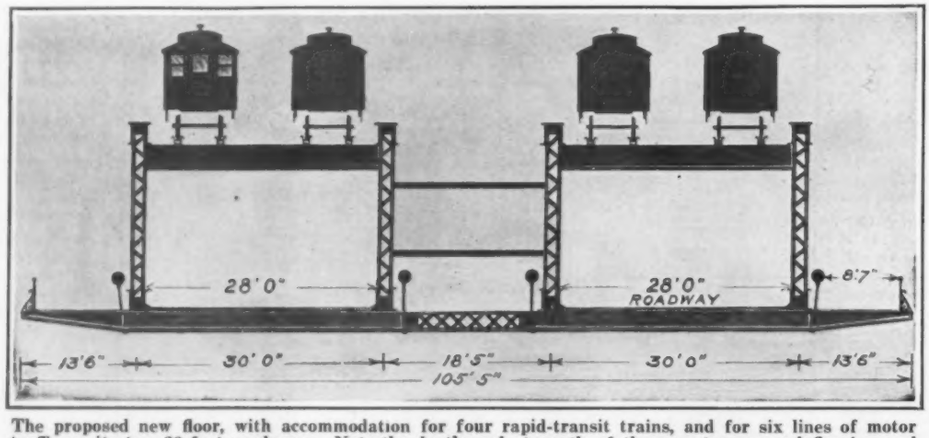
When we are run down, pale in color, and worn out by work and worry, the physician will generally prescribe some iron in the form of various tonics. The haemogoblin of the blood contains iron, which has the property of absorbing the oxygen in the air, breathed into the lungs, and forming with it a loosely combined bright red substance, which quickly loses its oxygen and changes into a purplish red color in the passage of the blood through the body and back to the lungs. The iron content of the healthy body is only 37 grains, but even a slight variation results in an anemic condition. The strangest thing about the treatment of anemia is the extreme difficulty of getting any iron into the blood. You can take large doses of iron salts, such as the carbonate or the hydroxide, but they undergo decomposition in the stomach and fail to reach their destination—that is, the blood—in a useful form. The same thing holds good of various organic iron compounds. It has been found, however, the colloidal iron drug will be absorbed into the blood very rapidly and really very good results have been obtained with it in the treatment of anemia.

Though iodine and sulfur are not metals, we may mention them here. In recent years the alcoholic solution of iodine, with the addition of a little potassium iodide to prevent the formation of iodic acid, has become very popular as an antiseptic, especially among British surgeons. Used in this form, it stains the skin badly, as is well known, and when taken internally or applied to parts of the mouth cavity, it produces a nauseous sensation and is very liable to give rise to iodine poisoning. Colloidal iodine is used in three forms, that is, in aqueous or oil solution or as a paste or ointment. Large doses of colloidal iodine may be administered with impunity and with no nauseous effects. When the colloidal iodine paste is applied to the skin it does not stain. Rheumatism has been treated very effectively, it is claimed, by soaking a piece of flannel with colloidal iodine, attaching the same to the positive pole of a battery and applying it as near as possible to the affected area. Nasal and bronchial inflammations can be alleviated very effectively by treatment with colloidal iodine.



Cross section of the present floor of the Brooklyn Bridge. Note the shallow and weak stiffening trusses, and the narrow 9-foot roadways

Colloidal sulfur has been used to replenish the impaired supply of sulfur in the body, which is the cause of liver trouble. The stomach will not absorb ordinary sulfur at all. Colloidal sulfur baths have been found to be very effective in the treatment of rheumatism and various skin affections. Colloidal alumina gel has been used as an astringent with excellent results in diarrhoea, being much less toxic than the bismuth compounds that are generally used for this purpose. Colloidal manganese was used with good results in the treatment of poisoning by mustard gas and other cases of sulfur poisoning. Colloidal copper is useful in the treatment of boils, while colloidal arsenic has been applied as a medicament in pernicious anemia. Colloidal nickel has been used in meningitis and colloidal palladium oxide has been applied successfully in the treatment of obesity by injecting it hypodermically into the fatty areas.



The proposed new floor, with accommodation for four rapid-transit trains, and for six lines of motor traffic on its two 28-foot roadways. Note the depth and strength of the new trusses and flooring and the two center platforms for the accommodation of electric cables, pneumatic tubes and gas mains.

Ammonia Table

A KNOWLEDGE of the thermodynamic properties of ammonia is of the greatest importance in the refrigerating industry. What steam tables are to the mechanical engineer, ammonia tables are to his colleague in the refrigerating industry. Nevertheless, in spite of their importance, heretofore such tables have been based on meager and inaccurate information.

Measurements of the specific heat of superheated ammonia vapor complete the measurements which the Bureau of Standards has been making for the purpose of establishing a table of thermodynamic properties of ammonia. The entire series of separate but correlated researches relating to the behavior of ammonia as a refrigerating agent has extended over a period of eight years. The work is the outgrowth of the appeal of the American Society of Refrigerating Engineers that the Bureau recommend an ammonia table for official adoption in place of the several more or less discordant tables then in use. The inadequacy of actual physical data and the element of choice in its selection and incorporation into the existing tables, together with the difficulty of making a judicious selection among these, made it inexpedient for the Bureau to choose any existing one, and as an alternative, measurements of the thermodynamic properties of ammonia were undertaken.

In this work the Bureau has had the valuable cooperation of the American Society of Refrigerating Engineers. As in the case of each of the preceding investigations of the series, the one just concluded has required the development of experimental methods, as well as the design and construction of special apparatus in preparation for the experimental work. The flow calorimeter used in the present work, together with the accessory equipment incidental to its use, required two years to perfect. Many refinements have been incorporated to adapt the apparatus to the wide range of temperature and pressure to be covered without sacrificing such valuable features as sturdiness, responsivity, reliability and accuracy. The determination of the value of the superheat of ammonia which has resulted from these measurements is not the most important part of the heat exchange in a refrigerating process, but a uniform accuracy of the table in all its parts is an advantage, and these measurements have maintained that accuracy. The working range covered extends from —40° C. (—40° F.) to +150° C. (+302° F.) and up to a pressure of 20 atmospheres.

The results of the entire series of measurements are embodied graphically in a Mollier chart which was presented at the Detroit meeting of the American Society of Refrigerating Engineers. This chart is doubtless the only similar chart of thermodynamic properties of a working fluid for a heat engine which is based entirely upon actual measurements made in one laboratory, upon a fluid of a definite quality, in a program of separate investigations, each complete, each planned and executed according to a high standard of accuracy, and all extending over the entire range of conditions to be covered by the table. The resulting data have been made thermodynamically consistent, not by mutual adjustment of values or by arbitrary choice, as in the previous tables, but by perfection of experimental technique to the point where outstanding discrepancies are negligible. In this respect the chart is unique in its class. The completion of this work makes ammonia better known as to its thermodynamic behavior within its working range than any other fluid.

Lord's Prayer in Space Approximately .001 by .002 of an Inch

THE Bureau of Standards was recently asked to measure what is probably the smallest piece of engraving on glass in the world. The engraving consists of the Lord's Prayer, 57-word version, engraved on glass in a space of .001 x .002 of an inch. The writing can only be seen under a high-power microscope, the magnification required being from 900 to 1000 times. The measurements by which the above dimensions were determined were carried out in the laboratories of the Bureau. The extremely small size of this engraving will be realized when it is considered that if a square inch were entirely filled with writing of this size, the entire Bible could be written 25 times in that space—in other words, something over 20,000,000 words could be written in a square inch.

This is certainly a very useless labor, as it has been demonstrated many times that engraving on glass can be carried out on such a small scale. Such painstaking work was quite the rage in the middle of the last century, and many curio collections have shells with the Lord's Prayer engraved upon them, but the work was nothing like as minute as in the case referred to above.

Left: Snow conditions on the trans-Andean railroad which is also scheduled for electrification. *Right:* Sixteen-car passenger train ascending the Tabon grade, behind a double-header

Railroading in the mountainous districts of Chile, where the electric locomotive is soon to replace steam

Railroad Electrification in Chile

An Extensive Undertaking to Insure the National Prosperity of Our South American Neighbor

By William H. Easton, Ph.D.

CHILE has decided to electrify her railroads. Work on the first section has already been started and full operation is expected by the summer of 1923. This initial electrification will include 144 miles of line; and while this is small as compared with the electrified mileage in the United States, our sister republic is, nevertheless, showing a progressiveness that, in at least one respect, far exceeds our own.

Unlike ourselves, Chile is not electrifying because she is forced to, because she is faced with transportation problems that can be solved in no other way. It is true that she experienced some traffic congestion during the war; that she has numerous mountain grades and long tunnels where the steam locomotive is handicapped; that her fuel costs are high; and that she has abundant water power. Each of these circumstances is, of course, favorable to electrification, but all of them taken together fail to justify the cost of electrification from a strictly economic standpoint at this time. Why then is she electrifying? Because she is looking ahead, not two years, but twenty, and she is electrifying because she is determined that her people shall be given every opportunity provided by engineering service to enjoy prosperity.

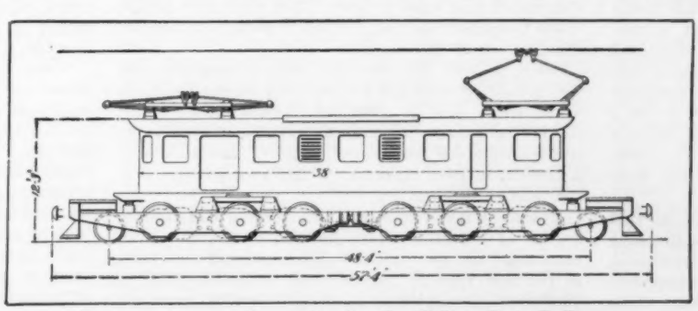
In other words Chile's leaders, backed by Chile's public, have ceased to be interested in eliminating any immediate transportation troubles by patching up their present railroad system; nor are they especially concerned with the fact that electrification will save fuel and perhaps show some real economies of operation. They know, from the experience of the United States, what traffic congestion means. They know how coal mines shut down for want of cars, while people freeze to death for want of coal; how agricultural products rot on the ground and at the same time bring famine prices in the larger cities; how industries shut down for want of materials that fill warehouses to overflowing at other points, but cannot be moved. They know these things and they propose, by electrifying their railroads, to prevent them from happening in Chile. It takes vision and courage to foresee a future difficulty and spend millions to remove it in advance, but Chile has shown that she possesses both.

Chile's Railroad System

Because of its position on the narrow western slope of the Andes Mountains, Chile is in many respects a unique country. It is 2600 miles long, north and south (or longer than the width of the United States between Canada and Mexico), but not over 300 miles wide at any point from east to west. The northern part of this strip is a desert, but is exceptionally rich because of the famous nitrate deposits; the southern part has excessive rainfall and is heavily wooded; while in between these two there is a smiling region of wheatfields, vineyards, and orchards, where the center of national life is located.

Were the long coast line favored with numerous natural harbors, the sea would undoubtedly be Chile's main highway, but unfortunately this is not the case. Practically all of the ports are merely open roadsteads. Hence, while there is considerable coast-wise traffic, the backbone of Chile's transportation system is a longitudinal railroad, running north and south through the center of the country, with laterals extending from this main line to the various sea ports.

The most important section of this system is the line which joins Valparaiso, the chief port, and Santiago, the capital, located in the interior 100 miles east of Valparaiso; from which a branch runs over the Andes to form the Chilean end of the trans-continental railroad to Buenos Ayres. This line is the focus of the traffic flow. Altogether, about 4000 tons of freight are carried over this line in each direction every day. This section, including the trans-Andean branch, will be the first to be electrified.



Express passenger locomotive for the Chilean State Railways

The Initial Electrification

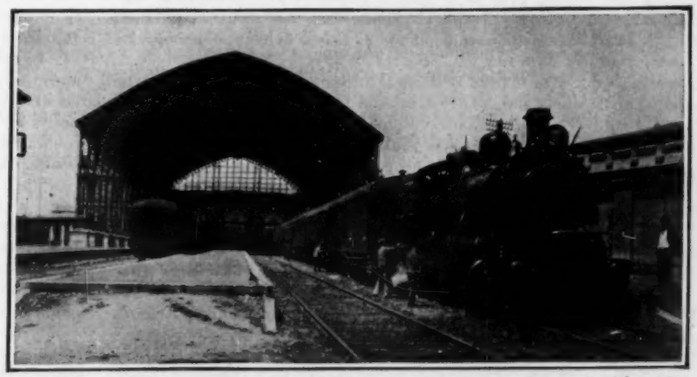
The initial electrification will include a stretch of one hundred and sixteen miles from Valparaiso to Santiago de Chile, and twenty-eight miles from Los Vegas to Los Andes, in addition. Thirty-nine locomotives will be required. These are to be of Baldwin-Westinghouse make and will have the following characteristics:

Type	Number	Weight tons	H. P.	Maximum speed, miles per hour
Express passenger..	6	127	2250	62½
Local passenger....	11	90	1500	56
Road freight.....	15	113	1600	40
Switching	7	65	480	34

The speeds of all these locomotives will be higher than those of the present steam locomotives. Regenerative braking will be utilized for the express passenger and road freight locomotives, but not for the local passenger locomotives, as the character of their service does not justify this refinement.

The electric power for the locomotives will be furnished at 3000 volts direct current from an overhead trolley. This power will be transmitted in the form of 110,000-volt alternating current and will be received by five substations located along the railroad and then transformed into the lower voltage direct current. The substations, as planned, will have capacity enough to handle more than double the 1917 traffic and are so laid out that their present capacity can be readily tripled.

The present railroad is of first-class construction and is well maintained. The rails are from 75 to 85 pounds in weight and are laid on Chile oak ties. The profile of the road shows a long pull from sea level to the divide, with one 2.25 per cent grade twenty kilometers long. With steam operation, helper-locomotives were needed for this grade, but the electrics will climb it without trouble. With coal at the present price of from $15 to $20 a ton, a reduction of from 60 to 80 per cent in the power bill is expected as one of the important advantages of electrification.



The Mapocho station in San Diego, Chile, showing American standard steam trains now in use

Our Point of View

The Truth About the Brooklyn Bridge

AS originally designed and built, the Brooklyn Bridge was provided with movable saddles to carry the main cables where they passed over the top of the towers. Between these saddles and the masonry, steel rollers were introduced with a view to permitting the saddles to move to and fro in the direction of the axis of the bridge. Such a movement would be caused by the uneven loading of the bridge by moving traffic. Thus, if there were more load on the center span than on the side spans, the flexible cables would tend to sag or take a deeper curve between the towers, and to straighten out or take a flatter curve between the towers and the anchorages on each shore.

In order to make sure that this movement of the saddles would be unobstructed, the steel rollers and the surfaces in contact with them should have been most carefully lubricated—preferably by being packed with some heavy lubricant held within a closed box or casing. This was not done, and evidently the saddles were left to shift for themselves; with the result that they rusted and stuck fast. Heaven only knows how long this condition has existed; but recently, due to a sudden congestion of traffic in the center span, and consequent extra loading, the pull caused thereby started the cables, so that there was a movement of one or two inches of the cables in the saddles at the top of one of the stone towers.

Now this incident, and it is nothing more, has been used by the daily press to work up a lot of scare-head articles designed to make the citizens of New York and Brooklyn believe that the Brooklyn Bridge is in a bad way—which it is not; and that it must be pulled down as having outlived its usefulness—which it has not. The Commissioner has proposed that a new bridge be built between the present Manhattan and Williamsburg bridges—a proposal which would involve the expenditure of forty million dollars for a structure which is not needed in that particular location. If a new bridge is to be built, the location should be between the 59th Street Bridge and the Harlem River, where it would serve a section of the city which is now without any bridge connection whatsoever.

We wish to assert with all possible emphasis that this attempt to persuade the citizens that the Brooklyn Bridge is unsafe, outworn, and ready to be condemned, is utterly at variance with the facts; is deliberately misleading; and is an attempt to create a doubt about the stability, strength, and permanence of a magnificent engineering work, which if it be properly cared for—which it has not been for several years past—will be capable of giving good service for a thousand years to come.

The steady increase in traffic across the bridge led to the consideration, some twenty years ago, of a proposal for the strengthening of the bridge, and for the increasing of its capacity. Plans for this work were drawn up and a report was filed by the Commissioner of those days, Gustav Lindenthal, which, if followed, would have doubled the capacity of the bridge; would have relieved it of unnecessary weight; and would have brought the structure up to date and given it the full benefit of modern engineering practise. Shortly after this report was made, there was a change of administration; the plans were pigeon-holed; and they lie today buried in the archives of the Bridge Department. The present Commissioner makes absolutely no reference to the existence of these plans, but prefers to talk about the necessity for building a new bridge at a cost of forty million dollars.

We direct the careful attention of the public to the plans for reconstruction of the bridge as shown elsewhere in this issue, reminding it that for the expenditure of ten million dollars the city would be provided with four Rapid Transit tracks and with two 28-foot roadways for motor trucks—this last an enlargement of the present roadway capacity by 200 per cent. The question is, shall the city expend ten million dollars in the enlargement of a bridge which it already possesses, or forty million dollars for the construction of a bridge, the necessity for which is as yet by no means apparent?

Blue Ribbon of the Atlantic

THE contest for the so-called "Blue Ribbon" of the Atlantic dates back to the era of the sailing ship—although the term was unknown in those early days. When steam became an auxiliary in the contest, the competition became very keen, reaching its climax when the Parsons turbine was introduced in the "Lusitania" and "Mauretania," and gave those two flyers a lead so commanding that further competition was discouraged.

The arrival at New York this year of that noble ship the "Majestic," and the subsequent reports of her having shown bursts of speed of 26 knots or more, has awakened interest in transatlantic racing, and many people are asking whether the "Mauretania's" record of 26.06 knots from America to Europe will be broken by her giant sister.

Looking back through the records of transatlantic passages we find that the first ship to approach 15 knots was the "Great Eastern," which on her best voyage in 1858 averaged 14.5 knots from coast to coast. It was not until a quarter of a century had elapsed that the "Umbria" of the Cunard Company brought the speed to 19.6 knots. She and her sister "Etruria" were the last of the single-screw ships.

The coveted 20-knot passage was made by the "Paris" of the old Inman Line, with a record of 20.7 knots. She and her sister "New York," with their twin screws and 20,000 horsepower, were the sensation of the day. This record was made in 1889. Then the record passed to the Cunarder "Lucania," which crossed at a speed of slightly over 22 knots.

Later, in 1897, the Germans made a bold bid with the "Kaiser Wilhelm der Grosse," and carried the mark to 23 knots, and in 1900 the "Deutschland" added another half knot, making the passage in 23.5 knots and taking 36,000 horsepower to do it. The Hamburg-American, in 1903, repeated the 23.5-knot passage with the "Kaiser Wilhelm II.

It was at this period that the turbine had reached a point of reliability which justified its use on a first-class liner, and the Cunard Company showed their faith in the new type by building two 31,000-ton ships of 72,000 horsepower. Both could do their 25½ knots and the "Mauretania" brought back the record to England by steaming, in 1907, from Sandy Hook to Daunt's Rock, Ireland, at 26.06 knots.

In their reply to the famous Cunarders the Germans made no attempt to match their speed; but they greatly exceeded them in size. The "Imperator" (now "Berengaria") of 52,000 tons and 70,000 horsepower, the "Vaterland" (now "Leviathan") of 54,000 tons and 75,000 horsepower, and the Bismarck (now "Majestic") of 56,000 tons and 75,000 horsepower, were designed to be 22½ to 23½-knot ships. The "Berengaria" has crossed at over 23 knots, and the "Leviathan" and "Majestic" are good for 24 knots, under the advantages of oil-firing.

The "Olympic" and "Aquitania" are both of the same size, 46,300 tons, and the same horsepower, 60,000. The former has crossed at 22½ knots and the "Aquitania," with her greater length and extremely fine model, has made the passage at 24½ knots.

It is interesting to note that the present holder of the record is an old ship; for the "Mauretania" has been 15 years in service. With her oil-fired boilers she is making her passages comfortably at from 25¼ to 25½ knots; and her record is in no danger from the huge vessels which have been built since her day. This will be evident if we remember that the "Mauretania" of 31,000 tons has nearly the same horsepower as the "Majestic" of 56,000 tons, or 72,500, as against 75,000. These figures, it should be understood, represent the maximum power that could be maintained continuously for a whole passage. So far as the engine horsepower is concerned, oil-firing, it should be understood, makes no increase in the maximum horsepower of the turbines. That is no greater with oil than it was with coal. The advantage of oil is that it enables the boilers to supply continuously the amount of steam which is necessary for continuous maximum turbine horsepower. The furnaces of coal-burning boilers must be cleaned at regular intervals, and while this is being done the rush of cold air into the furnaces causes a great drop of steam pressure. With oil-firing, the furnaces do not have to be cleaned, and full pressure can be maintained uninterruptedly from port to port. If the "Mauretania" were to be pushed to the limit, she could undoubtedly, under oil-firing, make the crossing at 27 knots.

That Good-Luck Chain

RUMOR has reached our ears, of late, to the effect that Europe is being devastated anew by a "chain" started by "an American officer," who sent a formal wish of good luck to each of nine friends, with the demand that each of them do likewise, and so on to no definitely stated termination. One of our good friends in England, who himself stands as a 41st link in this chain, has included us among his beneficiaries; so we are able to replace rumor, the jade, by personal experience.

The curious document which we have before us is headed "Good Luck." It then lists the persons through whose hands it has reached us; "Colonel Frank Miller to N. C. Melen to . . . to . . . to . . . and, at length, to our own defenseless selves. The previous 41 names are, of course, in carbon, along with the text; our own is added separately. The text makes it clear that this recital of the previous holders is part of the game. It reads:

"Copy this in full and send it to nine friends to whom you wish good luck. This chain, started by an American officer, should go three times round the world. Do not break the chain, for whoever does will have bad luck."

Our mathematical member points out that with nine recipients of the first link of this chain, nine times nine for the second, and so on, we shall have no less than 9^{41} recipients of the 41st link, which appears to be the current one. The 41st power of 9 is a very comfortable quantity—approximately 10^{39}, or a "1" followed by 41 ciphers.

The entire population of the world being something like 1,700,000,000, our mathematical member points out that, assuming that no links in the chain have been broken and that nobody is too illiterate to receive the chain, every one of us must have acted as the 41st link on no less than 6×10^{29} occasions. For discussion in the space here available we may well ignore the 40th and 39th and 38th links, and so on down—though on a mere basis of magnitude these are, of course, far from negligible. The point upon which we dwell, however, is that of 41st links alone, every human being would have received six hundred million million million billions, if the chain had done its full duty.

It seems customary to make all nine copies simultaneously, with carbon, and then to type in separately the nine separate recipients' names. After practicing the thing a few billion times, perhaps ten minutes would be a fair allowance for this task—one really can't type 42 names, with initials, etc., in much less time than this. On this basis, each one of us would have spent, in the transcription of his outgoing 42nd links, something like 10^{28} years—we leave the division to those sufficiently curious to make it.

Now some persons may feel that they have this amount of time to devote to this particular task. Our own attitude is that if we had nothing else to do, we should probably be grateful for such a completely absorbing task. But with several other things to be done staring us in the face—things which we regard as of equal importance—we are inclined to regard Colonel

Our Point of View

Miller's chain as infringing too largely upon eternity. A few million or a few billion years we should not begrudge; but ten million million million million years we regard as an unreasonable demand.

Readers of Huck Finn will recall that when the expedition had some hard luck coming to it by virtue of having killed a snake, they were quite prepared to wait patiently for the first misfortune that might occur, and attribute this to the snake's influence—if they had to wait a year for it. We have no doubt that, in the same way, a very respectable portion of the good and bad fortune which has overtaken the human race during the past few months has followed more or less closely upon the taking seriously of Colonel Miller's little *billet neuf*, or the refusal to take it seriously. But as conceding the *post hoc, ergo propter hoc*—well, that is something else.

When we carry reflection upon Colonel Miller's threat and his promise any further than this, we find it difficult to retain the humorous, or even the equanimous, attitude. We should like very much to know who this Miller person is who presumes to threaten you and us and everybody else with bad luck or to promise us good luck, contingent upon the reception which we give to his preposterous pronouncement. Just what is his "pull" with the fickle Goddess, that he can so confidently proceed to the parceling out of her smiles and her frowns? Is this peculiar influence his own peculiar possession, or can anybody else exercise it, also? If so, why; and if not, why not?

The most charitable explanation of Colonel Miller that occurs to us is that he may be a large holder of shares in the carbon-paper trust. We think most rational humans will agree with us that his curse is but a little bit more impious than his blessing. If he is a fair example of the sort of Homo Americanus with which Europe is in closest contact, it is small wonder that they have formed some quaint ideas regarding the Yankee breed.

Water-Power Possibilities in Ireland

IN the new and brighter era which has dawned for Ireland, the question of her industrial development is certain to play a leading part. Except in the northern counties, which are highly industrialized, Ireland is essentially an agricultural country. With an unusually fertile soil and a temperate climate, and under the stimulus of more favorable land laws, the Irish farmer has prospered, and the high quality of his farm products has won for him a ready and remunerative market.

It is in the industrial field, however, that the great development of the future will be accomplished, and in this connection special interest attaches to a recent report of the British Board of Trade on the water-power resources of the country. It is gratifying to learn that there are in the whole island 500,000 horsepower which can be economically developed. The chief sources of hydraulic energy are to be found in the rivers; and high-level lakes exist in the mountains of Wicklow, Donegal, and Kerry, which afford heads of water that it would be well worth while to develop for light, heat, power, and other industrial purposes. There is an abundance of tidal power, since the rise and fall around the Irish coast is considerable; but no use has been made of this type of energy on any extended scale, and development in this direction will have to wait upon demonstrations in countries that are better prepared for large expenditures of capital for experimental work.

The principal sources of energy, as we have said, are found in the rivers of Ireland. The report covers the Shannon, Erne, Bann, and Liffey, and it is suggested that these streams should be chosen first for hydraulic electric development. Over twenty years ago the river Shannon was investigated to determine its possibilities as a source of power, and during the interim a rather thorough study of the river has been carried on, with the result that the engineers are satisfied that this river is capable of supplying the central counties of Ireland with an abundance of power at a low rate. The tentative plans call for four separate power stations, with a total capacity of 66,000 horsepower, which could be developed at a cost of about $155 per horsepower. The river Bann could be made to furnish 12,000 horsepower, but, compared with the others mentioned, the cost of about $320 per horsepower would be high. There are other rivers, such as the Blackwater, and the Lee, which appear worthy of similar investigation. When the present pacification of Ireland has been completed it should not be difficult to secure the capital to put through these greatly needed projects.

Is Yacht Designing Decadent?

WE note that in a recent article in the *Western Morning News*, one, Sir Herbert Russell, expresses the belief that yacht designing is decadent; and when the writer asserts that the decline of racing among the larger classes of yachts in British waters is due largely to the effects of the war, we agree with him. The same cause has brought about the same results, though to a much less marked degree, in American yachting. But when Sir Herbert goes on to express his belief that the art of yacht designing is on the decline, we hold that the performance of the latest yachts affords a decided refutation of his statement. This critic draws attention to the famous yacht owned by the Prince of Wales, later King Edward the Seventh, and her excellent performance in last season's racing, when she showed up so well in spite of her age of over thirty years. It must be remembered, however, that when the "Britannia" was built, the only restriction placed upon hull measurements was that of length on the load-water line, and Mr. Watson, her talented designer, was free to make any choice of beam, draft, and overhangs, that he saw fit. Being thus unhampered it is not surprising that he should have turned out an able all-around boat, which was equally at home in sheltered waters, or in such a thrash across deep-sea water, as when she sailed her memorable race across the English Channel against the American "Navahoe." In the thirty years covered by the life of the "Britannia" the measurement rules have been amended times without number; partly because the earlier rules were defective, and partly in an effort to put a curb upon the ingenuity of yacht designers who were out first and last to "beat the rule."

That there has been no decline, but rather a distinct advance in yacht designing, is proved by the phenomenal speed shown by the 75-foot yachts "Resolute" and "Shamrock IV"; for it must be remembered that, nautically speaking, length means speed, and the "Britannia," with a length of about 87 feet, had an advantage of 11 feet over the two yachts of 1920. Nevertheless, you can find many yachtsmen who believe that either the "Resolute" or the "Shamrock" could give the larger "Britannia" a very close race, except perhaps in rough weather, when the greater size, weight, and staunchness of the older yacht, and her snugger rig, would probably enable her to show her heels to the lightly constructed cup yachts of 1920.

If by decline in yacht designing our critic means that the modern racing yachts are not so staunch as those of an earlier day, we entirely agree with him; for not soon will yachtsmen forget how both the "Resolute" and "Shamrock" "flunked" off Sandy Hook, when they were confronted by a 30-knot breeze and a steep sea—conditions which would have delighted the skipper of "Britannia" in her best racing days. But the trend of yacht design of recent years has been in the direction of extreme lightness of construction, largely by the use of the high-grade alloy steels which are available for frames, hull plating, and standing and running gear. Judged by the limitations of modern rules, and by the fact that the modern yacht is confessedly a purely racing machine, we think that the yacht designers of today will compare very favorably with those of the "Britannia" era.

The Year's Progress in Aircraft

WHAT Jane and Brassey have done for the naval world, the Aircraft Year Book of the Aeronautical Chamber of Commerce of America promises to do in the broad field of aeronautics. Although the aircraft annual is but a few years old, it has grown so rapidly, and is edited with such care and comprehension, that it is distinctly comparable in scope and quality to the long-established naval annuals above referred to. Within its 250 pages will be found an answer to every question which a year book may legitimately be expected to answer.

The book opens with a review of commercial aviation during the year, in which the fact is brought out that aircraft have continued to demonstrate their utility equally in the fields of commercial transportation and of military service. Chapter two deals with the problems of aerial transportation, such as the need for capital for proper terminals, landing fields, etc., and the urgent call for thorough reliability.

So important were the bombing tests carried out a year ago, off the Virginia Coast, that a considerable part of the third chapter is given up to a discussion of these tests. Each series is taken up in its turn; and it is needless to say that this digest forms in itself a very thrilling story, ending with the sinking of the battleship "Ostfriesland" by bombs of 2000-pounds weight.

One of the most valuable chapters of the book is that devoted to a review of aeronautics throughout the world, nation by nation; for here we have brought together a mass of information which only the facilities of such a body as the Aeronautical Chamber of Commerce render possible of collection. The fifth chapter on technical progress in aircraft construction during the year will be read with close attention by every aeronautical student. The subject is treated under the head of Army Airplanes, Naval Aircraft, Mail Airplanes, Commercial Airplanes, Racing Machines, Airships, and Aeronautical Engines. As a result of recent development, the Army Air Service possesses a two-seater, Dayton-Wright, night-observation biplane, with a 300-horsepower engine, which has a performance superior to that of the DH-4B, fitted with the 400-horsepower Liberty engine. Another type developed for the Army is the GAX Ground Attack Triplane, which carries a 37-millimeter quick-firing gun, and eight machine guns. The Martin bomber, with its two 400-horsepower Liberty engines, has been improved, and is considered now to be one of the best military machines of its class in existence. Other machines are two semi-cantilever monoplanes, a long-range day bomber, fitted with the McCook Field 700-horsepower engine; the Loening pursuit biplane, fitted with a Wright 400-horsepower radial engine, and the Barling bomber, carrying six Liberty engines. Among naval aircraft there have been developed the Curtiss torpedo dropper—a notable departure in seaplane construction. Great promise is also shown by the Douglass torpedo dropper.

A notable feature of this annual is the number and character of the illustrations, which are well-chosen for their purpose of showing the various types of machine, and particularly those which have won for the United States various records for height and speed. These include some excellent photographs of the airship bombing tests, and views of various useful services, such as forest fire patrol, in which the airplane has found a field of usefulness.

The Historical Design Section, which constitutes the second half of the volume, is packed with information. It opens with a complete series of line drawings, including plan, front and side elevations of the various types of American aircraft. These are followed by pen-and-ink drawings of the standard types of motor; and the work closes with a statement of aircraft appropriations by the United States Government, aircraft production costs, the activities of the Mail Service, and of the Forest Fire Patrol. Finally there is a very complete chronology of aircraft happenings for the year 1921.

Bell and His Telephone

Some of the Little Known Facts About the Great Inventor and His Work

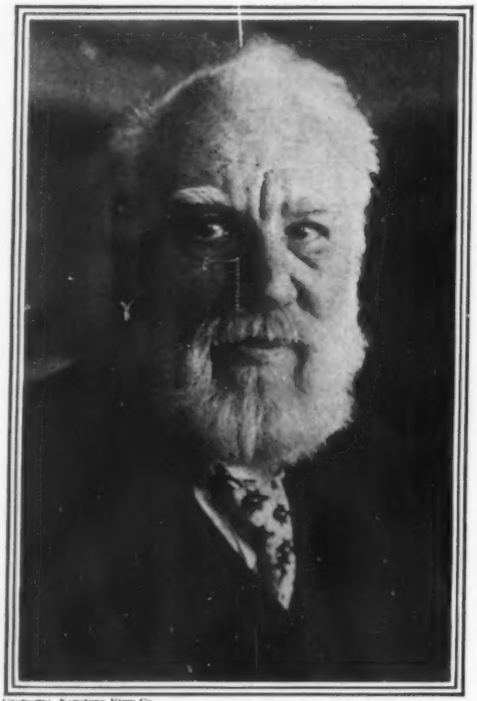
SEEING one's invention develop from a crude laboratory toy to a means of communication involving millions of conversations daily throughout the world—what more could an inventor wish for? Such was the experience of Dr. Alexander Graham Bell, who died on his estate, Beinn Bhreagh, in Nova Scotia, during the early morning of August 2 last.

It was while experimenting with a harmonic telegraph system whereby he hoped to transmit ten or twelve messages simultaneously over a single telegraph circuit that Dr. Bell, then a young college professor in Boston, literally stumbled across the means of transmitting sounds over wire. That was in 1874. From that point on young Bell went through the usual struggles of an inventor. He spent some time developing his first "talking telegraph," as he called it, and then endeavored to convince the world of the merits of his invention. It was during the Philadelphia Centennial Exposition, in 1876, that Bell's invention received official recognition. From that time on the story of the telephone is one of steady and rapid progress. Many inventors devoted their efforts to developing certain features of the telephone system. Hundreds upon hundreds of telephone men have perfected various phases of telephony. Theodore N. Vail, the late president of the American Telephone & Telegraph Company, and Bell's other associates worked on the business side of the telephone, bringing into being the remarkable telephone system which now spreads out over this entire country. Yet—first, last and always—Bell's name has persisted in all telephone work.

The story of the telephone and its wonderful development is too well known and has been so widely published, both recently and in the past, that it would be useless reiteration to review the facts once more in our limited space. However, there are certain phases of Bell's work which have been overlooked and which, therefore, are worthy of mention at this time.

First of all, we learn from the files of the SCIENTIFIC AMERICAN that Bell's first real telephone had the general appearance of the receiver now so widely used on wall and desk types. However, instead of using the present construction of a long horseshoe magnet with two solenoids, it had a single bar magnet with a single solenoid. The same instrument was used for transmitting and receiving purposes, just as a speaking tube is used in a dual capacity. No batteries were employed. A description of the operation of this simple telephone reads as follows: "The influence of the magnet induces all around it a magnetic field, and the iron diaphragm is attracted toward the pole. Any alteration in the normal condition of the diaphragm produces an alteration in the magnetic field, by strengthening or weakening it, and any such alteration of the magnetic field causes the induction of a current of electricity in the coil. The strength of this induced current is dependent upon the amplitude and rate of vibration of the disk, and these depend in turn upon the air disturbance made by the voice in speaking, or in any other similar source. Therefore, first, a wave of air throws the diaphragm into vibration; second, each movement produces a change in the magnetic field; and, third, an induced current is generated in the coil wire."

Simply stated, merely speaking into the instrument produced a delicately modulated electric current which flowed over the line to another similar instrument, the diaphragm of which was set into vibration by the modulated current and in turn reproduced the original sounds by causing air waves. Even at this late date electrical experimenters are often surprised and elated to learn that they can use the ordinary telephone receiver as a combination transmitter and receiver, even without a battery. Of course, the use of a single instrument is extremely awkward, and this crude arrangement is by no means comparable to the usual transmitter and receiver with battery combination.

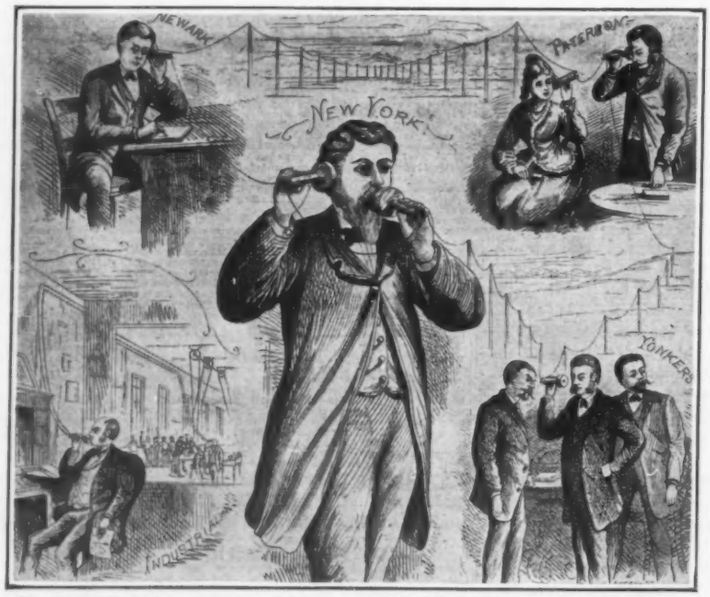


Courtesy, Keystone View Co.

Recent portrait of the late Dr. Alexander Graham Bell, the inventor of the telephone

Bell realized all this, for he soon made use of two receivers, one as a transmitter and the other as a receiver.

Still another phase of early telephony gathered from our old-time issues is the delivering of speeches and music by telephone. We like to pride ourselves in our remarkable achievements, and only too often we take it for granted that our ideas are absolutely new and original. Yet radio broadcasting today is nothing more or less than Dr. Bell's early use of the telephone. His medium was the wire telephone; the modern medium is space. Bell could accommodate but a few listeners; our radio broadcasting accommodates hundreds of thousands. With all that and more, however, the basic idea has remained the same.



Reproduction of a woodcut which appeared in the October 6, 1877, issue of the Scientific American, and which illustrates the early application of the telephone for transmission of lectures and for intercommunication purposes

Our large illustration is taken from the October 6, 1877, issue of the SCIENTIFIC AMERICAN, and, according to the accompanying text, "affords an excellent idea of how the instrument is used, and also of about the extent of circuit over which it is known to be capable of successful operation. We suppose the closed wire circuit to extend from New York to Newark, thence to Paterson and Yonkers, and back to New York, a distance of about 50 miles air line, or some 70 miles by railway. The figure marked New York may be considered as a public speaker delivering a lecture to be heard in the towns mentioned. He talks into one telephone, while he holds another to his ear, in order, for example, to hear the applause, etc., of his auditory; or he may be maintaining a discussion or debate, and he then hears his adversary's replies or interruptions. Now, at Newark there is simply a reporter, who takes down the speech phonographically; the words pass on through that telephone and reach Paterson. Here we show two persons, each with a telephone, the two instruments being connected. Each hears with his own instrument. Perhaps, in the future, operatic or concert companies will simply send out telephones enough to present each person of their audience in a distant city with an instrument apiece, and do their talking and singing once for all in the metropolis. In Yonkers we show three persons listening to a single instrument, which may be done in a quiet room. Finally, in a side sketch we show how the telephone is arranged to serve as a speaking trumpet between office and shop in a factory. Of course, for a long circuit there would be earth connections instead of the wire loop."

So Dr. Bell, during his seventy-sixth and last year, lived to see broadcasting by radio—a far more efficient, far more expansive, far more wonderful development than he would have dared to predict during his early demonstrations. Meanwhile, another application, the usual telephone, has become an everyday necessity. His telegraph aspirations have been exceeded by far. Numerous messages are now sent simultaneously over a single circuit. The operating of a typewriter keyboard at the transmitting end operates automatically a typewriter at the receiving end which types the actual telegram! All these things have come to pass in the short span of forty-six years.

Hypnosis and Surgery

FOR a long time it has been recognized by surgeons that the patient before an operation should be made to sleep, in order to gain strength in mind and body, and while this can be accomplished by the administration of narcotic drugs it were much better to avoid these and use mental suggestive and hypnotic methods instead. In an article, which appeared in the *Deutsche Revue*, written by Dr. Fiedlaender, there is described some very interesting experiences, dating back to 1905, with hypnosis of patients before and during operations.

The advantages of hypno-narcosis, as the author calls it, are many. The fear of the patient about to undergo an operation is known to every surgeon and interne. Many times it becomes necessary to administer morphine and other drugs to quiet the nerves of the patient. By the hypnotic process, the patient is hypnotized directly before the operation. The administering of the anesthetic is accomplished without his knowledge and slowly, so that the narcosis condition sort of creeps into the hypnotic state already existent in the patient. As soon as the operation is over the narcosis ends, but the hypnotic condition continues.

Only two-thirds to three-fifths of the quantity of anesthetic ordinarily necessary is used, with the result that the poisoning effect, brought about by ether, for example, is much reduced. The patient is not nearly so much distressed. There is no nausea. The continuance of the hypnotic state for several hours and even days allows the patient to recover from the immediate after-effects of the operation, which are always accompanied by acute pain and mental distress. It avoids the use of drugs, which must be given the patient frequently to overcome the severe strain on his outraged nerves.

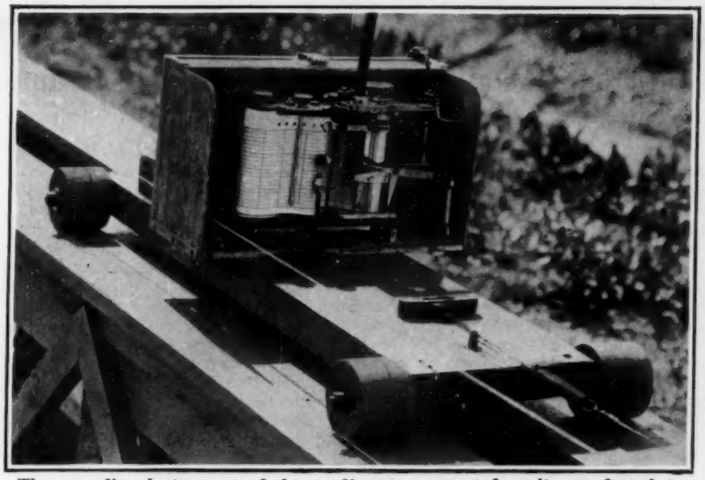
Taking the Roughness Out of Our Roads

TWO new devices of particular importance in studying the effect of road-surface irregularities and the increased impacts which they produce under heavy traffic strain have been perfected recently by the expert engineers of the U. S. Bureau of Public Roads and are now being used in experimental work on test roads located near Springfield, Ill. For a long time road builders have believed that roughnesses in road surfaces were objectionable, both from the point of view of those who have to travel the highway and also on account of the damaging forces which the uneven surface developed. Heretofore there has been no satisfactory apparatus available with which to measure these construction defects. Uncle Sam some months ago got busy on the problem of inventing such devices. They have now been improved to an extent where confidence is felt that they will be of outstanding value in the satisfactory completion of highways which will correspond in every particular to the special specifications relating to smoothness of surface.

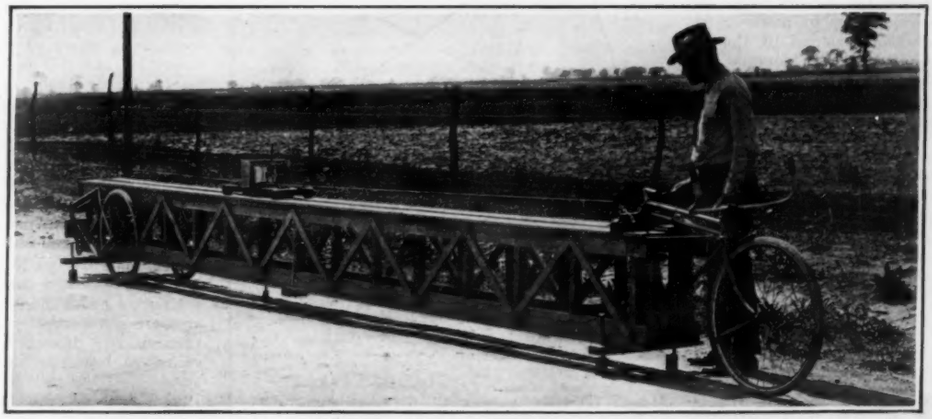
One of these instruments is known as the profilometer and is used to measure the roughness of highway surfaces. It permits of rapidly obtaining information in full about the profile of the road at any point. In addition to being a valuable device for testing old roads, this apparatus is also of importance for the use of engineers engaged in highway construction, as it provides a simple and practical means for them to obtain at any time facts and figures concerning the smoothness of surface of the pavements which they are building. By its use, new roads can be built so that they will correspond closely to the surface smoothness specifications.

As described by one of its originators, and illustrated in our cover painting, the profilometer consists of a straight-edge or track which is 24 feet long and a special recording attachment which when drawn over the track records accurately and autographically the profile of the paved surface beneath. During the initial testing activities this track has been set up on ordinary bicycle wheels. It consists of two wooden trusses 24 feet in length and 20 inches high, with a 3-inch space between them. Two turn-screws at each end of the track are used for leveling purposes each time it is set up at a station for a new test of the road surface. A piano wire is stretched tightly and uniformly between the ends of the track and is used as a register to determine if any sag in the track occurs.

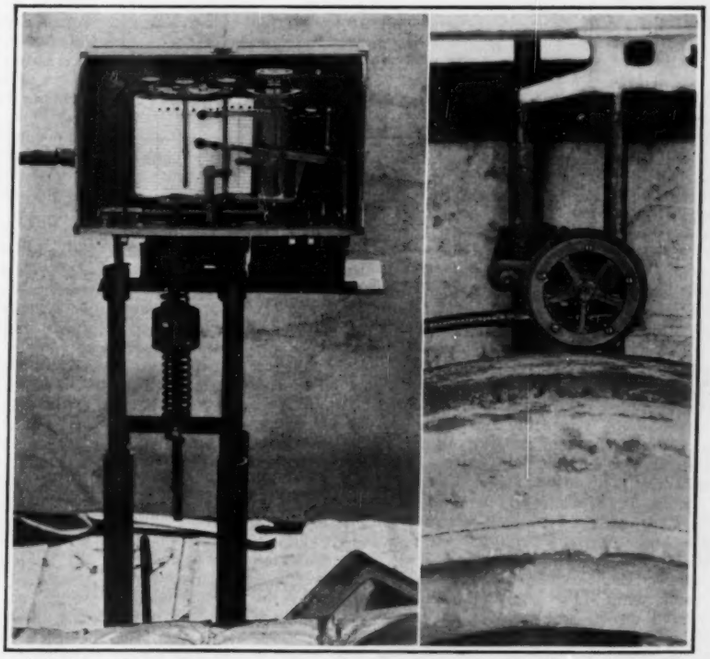
The recording mechanism includes a strainograph, to the pen arm of which is attached a rod that terminates in a brass wheel which by its movements detects the irregularities in the surface of each strip of roadway tested. The vertical movements of this wheel, which are brought about by the irregularities in the surface of the pavement, are traced by the registering pen on the recording paper. This instrument is mounted on a wooden platform that is 1½ by 3 by 30 inches in size and rides over the trusses on four wheels. The platform is kept centered by two additional wheels which run in the 3-inch space between the trusses. A wire cable attached to each end of the platform and passing over a pulley at each end of the trusses is used for drawing the recorder over the track. One end of the pulley terminates in a crank which is used to work the contrivance.



The recording instrument of the profilometer, mounted on its wooden platform. As it is drawn along the track provided by this platform it makes an accurate profile record of the stretch of roadway beneath



The tricycle mounting of the profilometer. The instrument is not used while the tricycle is in motion, but measures rather the roughness or smoothness of the stretch of road upon which the carriage is brought to a halt. The wheeled mounting is merely in the interests of portability



Left: Pen and recording drums of the accelerometer, which measures the impact of a big truck as it drops into a depression in the pavement. *Right:* Showing how the accelerometer is connected with the wheel of the motor truck whose blow it registers

Another instrument for measuring the roughness of a road by means of its effect upon the course of a heavy vehicle

There is another special attachment on the profilometer consisting of a small fiber strip which operates against the recording arm of the apparatus so that the upward movement only is recorded. By breaking an electrical circuit once every ten revolutions of the wheel an accurate record of the total upward movements of the wheel can be obtained. The average of all these measurements divided by the length of the road surface tested gives the index of the roughness of the road. The rolls which work the recording paper are operated by a pulley that is made to revolve as the platform is drawn across the track. This means that the recording paper moves a distance proportional to that traversed by the metal wheel on the pavement surface. In the practical investigations carried out up to this time, the ratio of the paper length to observed surface distance has been 1:10.

This apparatus can be used successfully to determine the smoothness of any length of pavement. A preliminary step involves the taking of levels at stations that are 18 feet apart. Thereupon, the ends of the track are set over these points and then the recording device is drawn over it. It permits of ascertaining the smoothness of the road in a very short time and it is the most serviceable, short-order assistant of its kind available for the use of road-building engineers. The device can be used to determine the surface smoothness of new roads before they are opened for travel. Thereafter, similar observations can be made at regular intervals to find out the effect of constant traffic on such surface irregularities.

The novel profilometer is also being used in conjunction with a specially arranged accelerometer—it is fastened to a motor truck or heavily-loaded passenger car during the tests—for determining how the surface roughness of the highway affects the impact delivered to the roadbed by the motor wheels. The accelerometer—this apparatus was also invented by Uncle Sam's highway engineers—is composed of a recording part and its case, to the pen arm of which a rod supporting a weight suspended between two compression springs, is attached. By means of special rods this device is fastened to the rear axle of the truck or passenger car to be tested. In this set-up the recording paper also moves a distance proportional to that traversed by the motor wheel. The roll which carries the recording paper is driven by a speedometer cable and a small rubber-tired wheel which rests against the brake drum of the rear wheel of the truck.

The accelerometer operates according to a simple technical theory. In case no vertical acceleration of the axle occurs, the weight will not change its position with respect to the axle and the record will be a straight line. However, if any vertical acceleration develops, the path of the pen will vary from this straight line. The greater the acceleration, the more will be this deviation from the straight line. This variation is always a measure of the force that causes it and such force can be ascertained by calibrating the springs. Having determined this force, the expert engineers can then ascertain the mass of the wheel and axle. From these data they can compute the impact. Government experiments are now in progress for studying the effects of surface variation on motor truck wheels.

The "Lusitania" and the Submarine Salvor

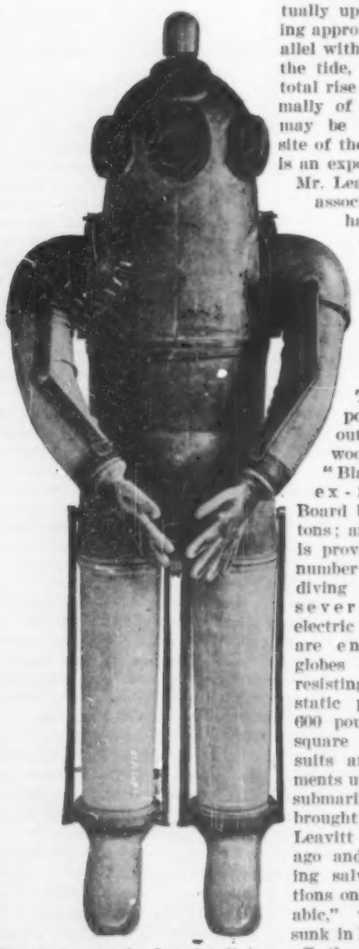
Some of the Schemes Proposed for Dealing with the War's Most Famous Wreck

By Robert G. Skerrett

THE inventive mind has been busy ever since the "Lusitania" plunged to her untimely end in May of 1915; and the records of the patent files here and abroad disclose a large number of methods and apparatus wherewith, it is claimed, that deeply sunken craft can be dealt with effectively. The purpose of the present article is not to review these manifold schemes, interesting as many of them are; the object is to call attention to three aspects of the problem and to mention a few of the ways in which these angles of the matter may be attacked. This treatment of the subject does not imply that we have confidence in any of them.

Broadly stated, salvage operations in connection with the "Lusitania" might consist in refloating the vessel and in moving her to a sheltered haven. The raising of the liner may be effected in either of two ways—*i. e.*, by buoyancy applied within her body or by buoyant media exerting a lifting force outside and upon the wreck through wire ropes or chain cables attached to the ship in a suitable manner. Or, the salvors might confine their labors to the recovery only of more or less of the valuable articles or goods carried by the steamer when she foundered—letting the "Lusitania" remain upon the seabed. Indeed, an attempt of the latter nature is shortly to be made; and special apparatus has been devised by B. F. Leavitt to promote the undertaking.

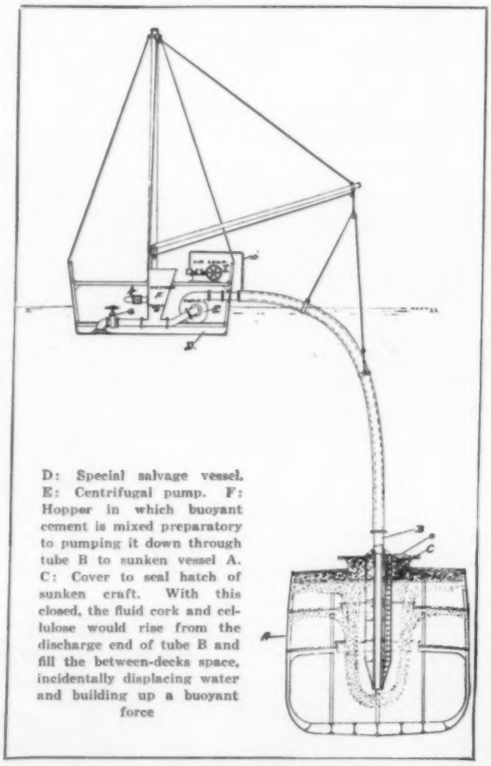
It is commonly agreed that the "Lusitania" rests upon a hard-shell bottom in water ranging from 38 to 42 fathoms in depth, and at a point about eight miles off the Irish Coast between Seven Heads and Old Kinsale Head. While no one has established the fact, the opinion prevails that the "Lusitania" is virtually upright and lying approximately parallel with the sweep of the tide, which has a total rise and fall normally of 11 feet. As may be realized, the site of the catastrophe is an exposed one.



Front view of the Leavitt diving armor

Mr. Leavitt and his associates, as we have indicated above, plan to recover cargo only, and only the more valuable of the cargo, at that. To this purpose they have outfitted the wooden steamer "Blakeley," an ex-Shipping Board boat of 2800 tons; and the craft is provided with a number of all-metal diving suits and several deep-sea electric lights which are encased in globes capable of resisting a hydrostatic pressure of 600 pounds to the square inch. The suits are improvements upon kindred submarine armor brought out by Mr. Leavitt some years ago and used during salvage operations on S.S. "Pewabic," which was sunk in Lake Huron off the east coast of Michigan in 1865. That vessel lay 176 feet below the surface, and therefore at a depth which could not be approached without great hazard by a diver in the ordinary type of dress. In fact, the greatest depth at which useful work has been done is 182 feet. At this depth a Spanish diver recovered $9000 in silver bars from a wreck off Cape Finisterre. But this is altogether exceptional; but two other cases of useful work at 150 feet or more are on the records; and ordinary dock and harbor work is conducted at depths between thirty and sixty feet.

After demonstrating that he could descend 360 feet in his all-metal suit, and remain at that depth for 45 minutes, experiencing no physical distress the while, the same apparatus was employed during 1917 and 1918 in locating the "Pewabic" and in directing from

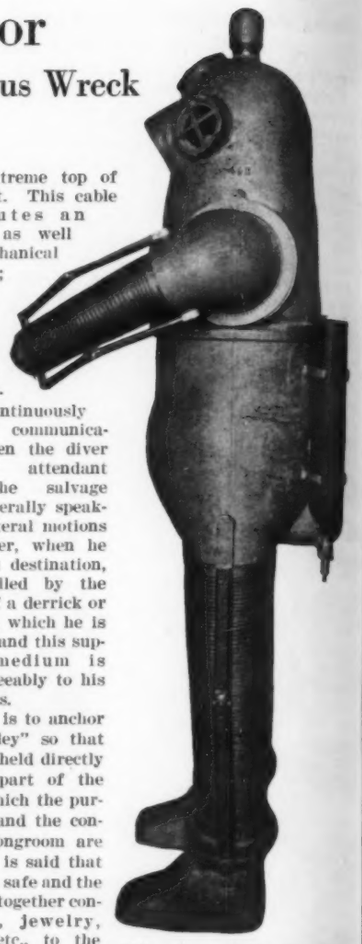


D: Special salvage vessel. E: Centrifugal pump. F: Hopper in which buoyant cement is mixed preparatory to pumping it down through tube B to sunken vessel A. C: Cover to seal hatch of sunken craft. With this closed, the fluid cork and cellulose would rise from the discharge end of tube B and fill the between-decks space, incidentally displacing water and building up a buoyant force

Simon Lake's system for refloating deeply sunken vessels

under water the recovery of part of her remunerative cargo. The actual salvage work was done by big grab buckets. The present suits are constructed of bronze and weigh 350 pounds apiece. When submerged this weight is cut down to about 75 pounds by reason of the displacement of the diving dress. The arms and the legs of the armor are fashioned of flexible metal tubing, and can be bent at the elbows and the knees, respectively. Further, the shoulder sockets are watertight, annular joints, supported by ball bearings. This arrangement is counted upon to give the arms considerable movement and to offset any locking or jamming pressure of the enveloping water.

The suit is self-contained, inasmuch as the diver does not draw air from the surface through a connecting hose but gets his respirable air from a regenerative attachment. This is composed of a cartridge or case filled with caustic soda, which absorbs the exhaled carbonic acid gas, and of a steel flask charged at high pressure with oxygen. The latter, placed outside and at the back of the suit, furnishes just enough oxygen to make up for that consumed by the body; and a special type of reducing valve feeds this life-giving element into the free space within the diving dress to meet the physical needs of the occupant for a period of fully three hours. The encased man is lowered into the depths and brought up to the surface by a small steel cable, of a non-twisting type, secured to the extreme top of the helmet. This cable constitutes an electrical as well as a mechanical connection; its core carries a circuit providing means for carrying on continuously telephonic communication between the diver and his attendant aboard the salvage craft. Generally speaking, the lateral motions of the diver, when he reaches his destination, are controlled by the swinging of a derrick or boom, from which he is suspended, and this supporting medium is shifted agreeably to his vocal orders.



Side view of the Leavitt all-metal deep-diving suit, with oxygen flask at rear

The plan is to anchor the "Blakeley" so that she can be held directly over that part of the wreck in which the purser's office and the contiguous strongroom are located. It is said that the purser's safe and the strongroom together contain gold, jewelry, securities, etc., to the value of $6,000,000. Divers will descend to the uppermost deck where they will place charges of dynamite above and in line with their goal; and it is claimed that when these cartridges are detonated electrically that they will clear a way through that deck. Similarly the aim is to make widespread gaps in one or more of the decks below, and thus to create a yawning passage through which the divers may be lowered to their objectives. Then, by means of bucket dredges and other lifting tackle, the packages in the strongroom may be lifted to the surface. The "Blakeley" is equipped with a steel cargo boom capable of handling a load of 30 tons, and this is counted upon to raise the purser's safe when lines have been secured to it. The deep-sea electric lights, we are told, will illuminate the scene of operations within the "Lusitania."

Maritime wreckers of wide experience do not believe that either dynamite or nitroglycerine will be of much use in smashing and clearing away structural steelwork lying between the treasure seekers and their goal. Where these explosives have been used under water heretofore they have commonly produced a maze of tangled plates and angles and have brought about a condition that would ordinarily check the advance of a courageous diver in the usual dress and familiar with difficult subaqueous tasks. However, Mr. Leavitt is seemingly undismayed by his critics.

In contrast to this project are some of the systems developed to effect the refloating of the "Lusitania"—a far more staggering task than that just described. One of the most ingenious schemes is that offered by Simon Lake, which would utilize a buoyant force exerted from within the wreck. To this end, he would fill the damaged craft with enough material of a permanently buoyant character to overcome her dead weight so as to cause her to break away from the seabed and to rise to the surface. This, in itself, is not essentially novel, but the means which Mr. Lake would employ to achieve his purpose are unique. His proposition involves nothing more complex than pumping down and into the liner, after certain openings have been sealed, a large volume of cork or balsa wood mixed with melted paraffin. The paraffin would be heated in

a tank provided with steam coils, and, when sufficiently fluid, would be fed into hoppers where it would be mixed with small blocks of cork or balsa wood. From the hoppers the buoyant stuff would be led to powerful centrifugal pumps which would send it, by way of insulated pipes of goodly diameter, down into the holds and 'tween deck spaces of the foundered ship.

Each cubic foot of the combined paraffin and woody matter weighs about 14 pounds, while every cubic foot of salt water displaced thereby weighs 64 pounds—the net result being a buoyant moment of 50 pounds. Inasmuch as the compound remains plastic for some time when surrounded by cold water, and as its tendency is to float upward, this light substance would attach itself first to the undersides of decks, fill interstices and small openings generally, and gradually push the water downward and outward through any passages that afforded avenues of escape. On hardening, this cement attains considerable rigidity, and its lifting effort would be distributed over a wide area against the superposed structure of the craft. This action would avoid any localized buoyant stresses which might be apt to occasion damage to the steel work and call for costly repairs afterwards. When safely landed in a drydock, the removal of the buoyant mass could be speedily accomplished by means of picks and shovels or by the cutting action of jets of steam. Mr. Lake claims that by this system he would be able to pump his buoyant material into a sunken vessel at the rate of 300 tons an hour and thus, in a short while, concentrate sufficient lifting force to raise a ship having a dead weight of thousands of tons.

In passing, it may be said that various other schemes have been suggested by which buoyancy could be applied within a wreck. These run all the way from air-filled casks and bags to compressed air blown directly into some of the craft's compartments; but the consensus of opinion is against any of these expedients owing to two outstanding physical difficulties: first, the obstacles that would hamper placing casks or bags inside a vessel lying at so great a depth, and the well-nigh prohibitive conditions under which divers would have to work to make suitable connections for the use of compressed air; and, second, the fact that unless the buoyant air was free to expand and to escape as the ship mounted from the seabed the buoyant element would actually exert a tremendous explosive force which might blow away the decks and permit the boat to sink like a stone.

And now we come to some of the projects developed for dealing with deeply-sunken ships by recourse to buoyancy applied outside the wreck. It is probably in this field of maritime salvage that the inventive mind has given itself the fullest expression. Many methods have been devised by which external buoyancy might be brought into play; and while some of them have been well thought out and are based upon long-established engineering principles still only one of them has achieved practical results. This last was employed by the Admiralty Salvage Section of the British Navy in 1918 and 1919, and consisted of a series of horizontal surface pontoons attached to steel cables passing under the wrecks. In one case, a laden collier, having a submerged dead weight of 2500 tons, was lifted from a depth of 72 feet by sixteen 9-inch wire hawsers; and another craft, having a submerged dead weight of 3800 tons, was similarly raised from a depth of 138 feet. The utmost care had to be exercised, and much time was consumed in effecting these reclamations. Ordinarily, it would not pay to follow the same procedure; and the fact that kindred measures have not been requisitioned to salvage the "Lusitania" and other totally submerged vessels in view of these precedents plainly shows that they are hardly fitted for commercial application.

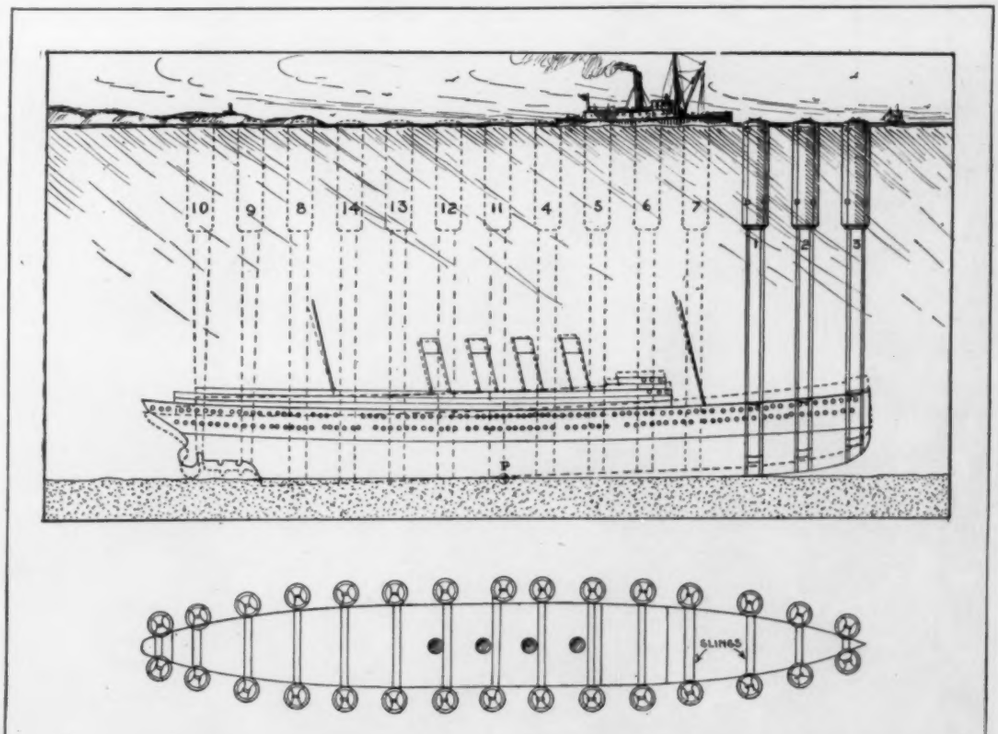
S. S. "Blakeley" while outfitting to attempt the salvage of the treasure aboard the "Lusitania" by the use of the Leavitt diving suit

Four years ago, the SCIENTIFIC AMERICAN printed an article descriptive of Carl J. Lindquist's system for the refloating of deeply-sunken ships through the medium of a novel type of vertical pontoons, and Mr. Lindquist is now satisfied that his pontoons are especially suited to handle the "Lusitania." The pontoons are designed to take in water ballast so that they may be partly submerged vertically a matter of 18 feet, and their pull is, therefore, not dependent upon the rise of the tide, as is usually the case with surface pontoons. Again, by utilizing vertical instead of horizontal pontoons, Mr. Lindquist puts his stresses upon the pontoons in the direction in which they are structurally best able to sustain a maximum load; and, what is equally important, the diameter rather than the length of his pontoons limits the number which can be arranged around a wreck. By an ingenious arrangement of sliding bits, mounted on top of each pontoon, the inventor provides an equalizing device which automatically maintains a uniform tension on the four cables connected to every pontoon and passing under the keel of the boat.

To refloat the "Lusitania," Mr. Lindquist would have recourse to twenty of his pontoons, each 30 feet in diameter and 75 feet in length, and capable of lifting 1000 tons. He believes the keel of the liner, both at the bow and the stern, rises 10 or 20 feet above the seabed, and this would permit "sweeping" hawsers in under her at each end. By placing strings under the bow and the stern first, and by rocking the ship alternately by the lifting and tugging action of the attached pontoons, he is sure that the grip of the seabed could be broken. With this done, other slings could be swept into position fore and aft beneath the "Lusitania" until so distributed that each would bear its proportionate share of the load. By expelling the water ballast from the pontoons they would rise and carry the steamer with them. The flotilla would then be towed shoreward until the wreck came once more in contact with the floor of the sea. The pontoons, at that point, would again take in water ballast to increase their draft, when the slack of the slings would be taken up. This process would be repeated until the coast shallows were reached, where ordinary salvage work would ensue.

Following in the footsteps of Mr. Lindquist, Mr. Jesse W. Reno has devised a system of multiple-unit, vertical pontoons which was described in the SCIENTIFIC AMERICAN of November, 1921. Mr. Reno does not rely upon slings passing under the keel of a submerged vessel, but would fasten his pontoons by means of hooked rods, right to the hull plating at points close to the framing where the structure would be strongest. The terminal hooks of the rods would engage holes bored electrically in the steel skin of the wreck.

With all of his pontoons in position, Mr. Reno would admit air to them through their open bottoms — directing the buoyant medium into the pontoons by a wheeled, seabed siphon or some other suitable apparatus. When the pontoons had acquired the needful buoyancy they would pull the wreck loose from the bottom of the ocean.



The pontoons are numbered in the order in which the several pairs would engage the wreck by means of slings passing under the vessel's keel. The ship would be rocked forward and back upon the pivotal point P, to facilitate sweeping the slings under her entire length. It is claimed that the vessel's position is such, and the shell bottom of such hardness, that it would be comparatively easy to get the wire-rope slings in place

The manner in which the Lindquist vertical pontoon might be used in the salvage of the "Lusitania"

New Orleans' Big Port Improvement

Preparing for the Future World Trade of the Southern Metropolis

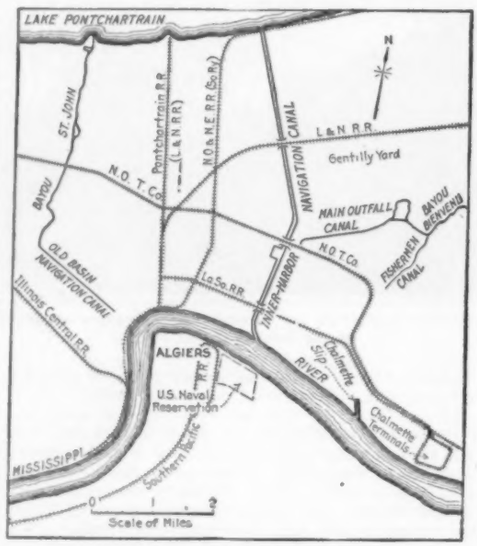
By S. G. Roberts

NEW ORLEANS is situated at the neck of a funnel. The whole of the Mississippi Valley is the hopper which, in the course of a twelvemonth, passes through the water gates of the city freight to the value of a billion dollars and more—about 5,000,000 tons of inbound and 6,000,000 tons of outbound commodities. Under the laws of Louisiana, survivals of the days of Spanish and of French dominion, the water frontage is inalienable public property and can be neither leased nor sold to private interests. This has made it next to impossible to provide New Orleans with adequate pier accommodations on the Mississippi, and at the same time has deterred industries which would have many reasons for establishing themselves in New Orleans if they could own and operate their own docks. In an effort to change this situation the legislature of Louisiana, in July of 1914, authorized the Commission Council of New Orleans to select the site, and the Board of Port Commissioners of Louisiana to undertake the construction of the so-called Industrial Canal. This artificial waterway, five and one-third miles in length and thirty feet deep at low water, forms a link between the Mississippi River and Lake Pontchartrain. The total cost will be inside of $25,000,000.

The canal is equipped with a great lock, which is set 2000 feet in from the Mississippi. Between the river and this lock the canal prism is 125 feet wide at the bottom with a span of 275 feet at the top, while between the lock and Lake Pontchartrain the canal is 150 feet wide at the bottom and 300 feet across at the top. The excavational task, when finished, will represent the removal of 10,000,000 cubic yards of earth. Though no rock had to be cleared away, still the digging has required somewhat unusual apparatus, owing to the presence of burned stumps and trunks of prehistoric forests. With special impellers to handle these it was possible to speed the performance of a dredge up to 445 cubic yards an hour.

The lock is virtually a single body of concrete and steel 1020 feet long, 150 feet wide, and 68 feet from top to bottom. With its five sets of steel gates, its emergency dam, and its operative machinery, it has a combined weight of 225,000 tons. Its concrete floor is from 9 to 12 feet thick; and the side walls taper from 13 feet through at the bottom to 2 feet at the top. The crest of the lock is 20 feet above the natural ground surface and rises 6 feet higher than the highest recorded level of the Mississippi River during a flood period. The ground on each side is sloped away in a series of broad terraces, and this earth fill is counted upon to reinforce the walls of the structure against outward pressure. On the other hand, heavy, reinforced concrete anchor columns are placed outside the walls to support them against the collapsing thrust of the flanking earth when the lock is drained.

Before the construction of the lock, itself, could be taken in hand, it was necessary to dig a hole, with easy sloping sides, having a depth of 50 feet, a width of 350 feet, and a length of 1500 feet. This would have been a relatively easy matter had the engineers been dealing with solid soil. As it was, they had to contend with alternating strata of sand and blue clay, all of them carrying water; and in the case of the sand strata most of them were fluid, *i.e.*, quicksand. To add to the difficulties, marsh gas, at a considerable pressure, underlay some of these blankets of alluvial deposit.



Plan of the Lake Pontchartrain canal

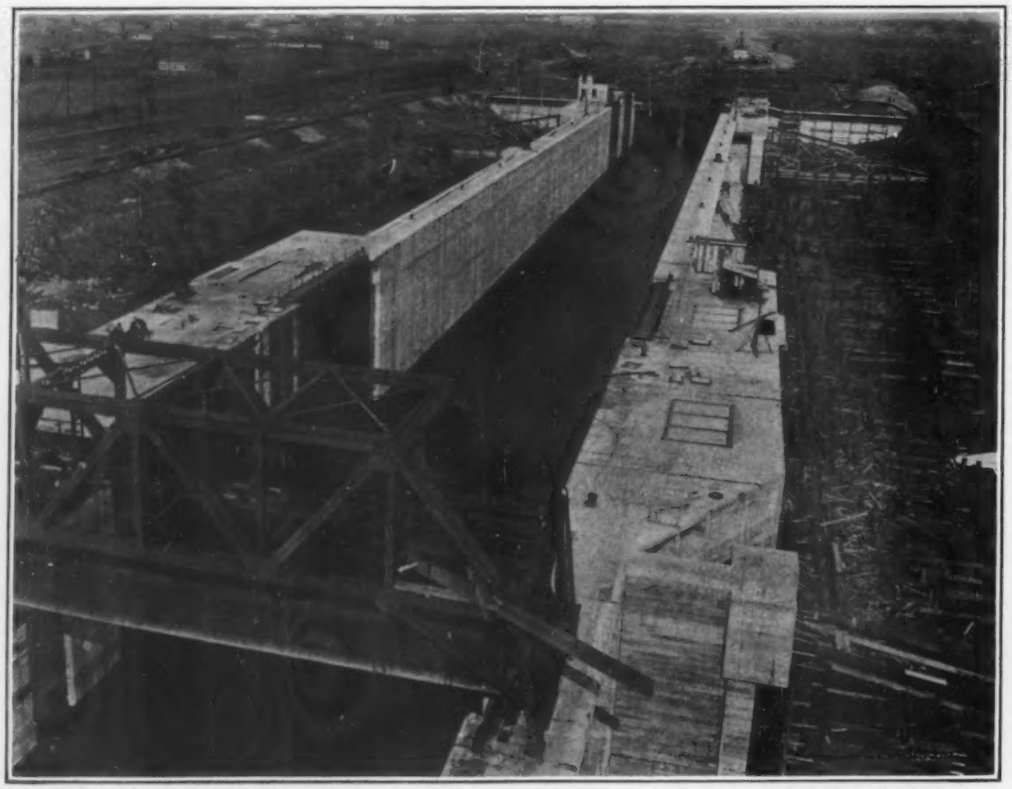
Test borings had disclosed the character of the subsoil; and the experts believed that the unstable nature of the ground could be neutralized by surrounding the lock area with a barricade, so to speak, of piling. Therefore, while the dredges were in action, a cofferdam of wooden sheet-piling was erected around the lock site, about 125 feet from the edge of each bank, for the purpose of cutting off the first quicksand stratum. A while later a second ring of sheet piling was driven within the first one, the idea being to shut out the second stratum of quicksand. But when the work of unwatering the lock site was started, the quicksands forced their way through the sheet piling in streams and caused the walls of the excavation to give and to cave in. The conditions were aggravated by the vigorous upward movement of the marsh gas.

To arrest further disruption, a large volume of water was pumped into the excavation. This superposed weight overcame both the ground pressure and the vertical thrust of the marsh gas in the underlying earth. A third ring of piling was built inside the two others. This cofferdam was of steel sheet-piling, braced by heavy, wooden beams. By way of an added precaution against blowouts from the third stratum of quicksand, no fewer than 130 ten-inch artesian wells were sunk within the enclosure; and 56 similar wells were driven between the steel and the wooden cofferdams to drain or at least to reduce to a harmless minimum the flow of the second stratum of quicksand.

The unwatering of the lock site was resumed in November of 1919, but only a foot of water was pumped out daily, and the draining was not completed until early in January of 1920. Movement of the defenses was observed in but a single place; a section of the wooden sheet-piling, about 300 feet long, was bulged inward a maximum of three inches before the bracing effectually checked the tendency to give way. Finding that there was no likelihood of further hampering displacements of the ground, the constructors then proceeded to stiffen the support or foundation for the great monolithic lock. To this end, 24,000 piles, each 60 feet long, were driven their full length into the bottom of the cut. With these in position, the concrete forms were reared; and the pouring of this material was done in 15-foot sections.

It is estimated that the lock can be filled or emptied in ten minutes. The lock gates weigh 200 tons each. These gates are opened and shut electrically. As a safeguard against their failure to close during high water, the engineers have provided what is termed an emergency dam, which is made up of eight sections, 80 feet long, 3 feet wide and 6 feet high, weighing 90 tons apiece. They are placed on a platform near the river end of the lock within easy reach of a big crane, which can pick them up and drop them into the slotted recesses designed for them in the lock wall. To assemble the emergency dam requires about an hour's time. This dam would protect the city from inundation, and is also counted upon to insure the uninterrupted functioning of the lock in normal times if the gates should be damaged by a ship or otherwise put out of commission.

The Inner Harbor embraces both flanks of the canal and will later on include the neighboring shore of Lake Pontchartrain. It is intended to form a navigational artery for a great industrial center connecting with nine trunk-line railroads. The aim is eventually to furnish a shorter route to the Gulf, via Lake Pontchartrain. Such a waterway would effect a saving of 50 miles as against the passage now followed from New Orleans down the River to the Gulf, and vice versa. The accompanying map shows the canal's location and the surrounding territory.

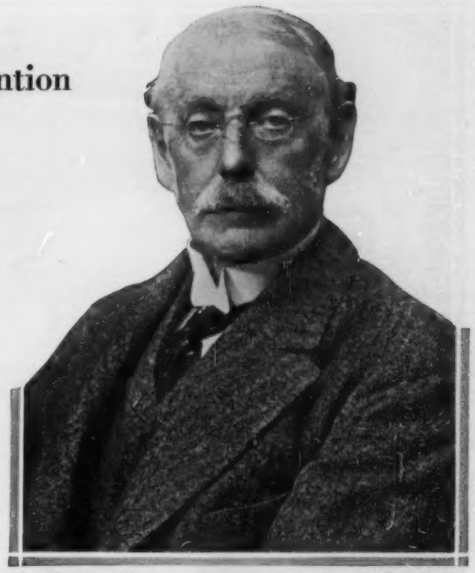


The finished lock of the Inner-Harbor Navigation Canal, looking northward toward Lake Pontchartrain

The Parsons Steam Turbine

Story of the Early Struggles and Final Triumph of a Great Invention

By Hector C. Bywater

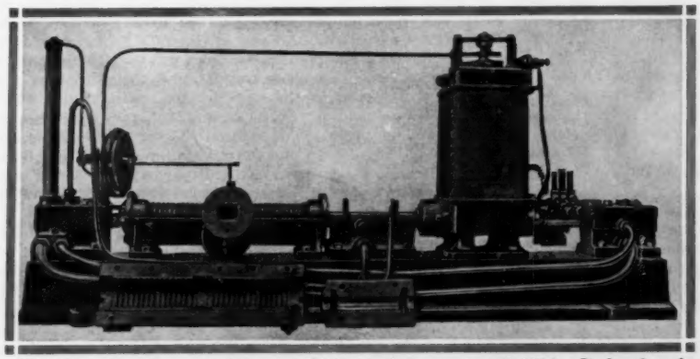


Sir Charles Algernon Parsons, inventor of the steam turbine, is the son of the Earl of Rosse, builder of the famous Rosse Telescope

THERE are few themes more inspiring than the history of an epoch-making invention, and its patient development from the germ idea through the various stages which finally culminate in its recognition as a valuable factor in the scheme of human activity; for every such achievement represents a triumph of intellectual force in combination with the dogged perseverance that refuses to be balked of its aim, no matter how formidable the difficulties that have to be overcome. The story of the Parsons steam turbine is full of interest alike from the "human" and the technical points of view, since it tells how a mechanical device which has revolutionized ship propulsion was brought to its present degree of perfection in spite of obstacles that would have daunted a personality of ordinary caliber. The steam turbine itself is no longer a novelty; its performances are familiar to every student of science and engineering; but of the man whose name is so intimately associated with its development the public has heard very little, because, like most great inventors, he does not court publicity. Knowing this, it was with some diffidence that I approached Sir Charles Parsons with a request that he would favor the SCIENTIFIC AMERICAN with some personal details of his life and work, and especially of those early days when he was experiencing the vicissitudes that invariably beset the career of the inventor. To this request he most courteously acceded, and I had the pleasure recently of a long conversation with him, in the course of which he talked freely about his work, though much less freely about himself.

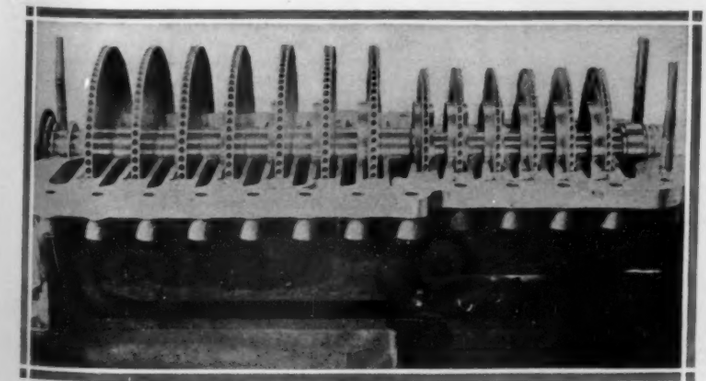
The Honorable Sir Charles Algernon Parsons, K.C.B., M.A., LL.D., D.Sc., F.R.S., was born on June 30, 1854, a younger son of the third Earl of Rosse. His father was not only a nobleman, but a scientist of high repute, who was president of the Royal Society—a learned body whose work in the cause of science is too well known to need advertisement—and had built at his Irish home the largest telescope then in existence. It has been well said by one of Sir Charles Parsons' admirers that he is a living example of hereditary genius, encouraged and developed by wisely-planned vocational teaching. Of his early days he has this to say:

"I was educated on what is called among engineers the 'sandwich system.' My father, rightly or wrongly, had a rooted objection to public school education (as the term is understood in England) and consequently, with my brothers, I was taught by tutors at our home in Ireland. Concurrently I had the advantage of working in well-equipped workshops where my father had constructed his telescopes, and from him I learned the first principles of mechanical construction and engineering, for he was a skilled engineer as well as a scientist and an astronomer. After that were interposed five years of pure and applied mathematics, including the Cambridge Tripos. I recall that the strain was more severe than anything I have experienced in business life, and, luckily for me, boat racing interfered with reading."



The first experimental Parsons turbine and generator of 1883. It developed 6 horsepower and was sufficiently successful to encourage the inventor to go ahead

While a student of St. John's College, Cambridge, he made several models of an epicycloidal or rotary engine with revolving cylinders, which at a later date was manufactured by him in considerable numbers. The ingenuity shown in designing this intricate machine was an earnest of those intellectual powers that were subsequently to be devoted to a greater problem. Graduating from Cambridge in 1876 with high honors in the Mathematical Tripos, he passed as a premium apprentice to the famous Armstrong workshops at Elswick, where he served for three years in overalls, and cheerfully tackled every job that came to his hand. In this hard school he gained a practical grounding in engineering that stood him in good stead in his later work. "Here," he says, "I learned from Sir William (afterward Lord) Armstrong the methods of mechanical research and construction that have made the Elswick works famous throughout the world, methods closely analogous to those which the workers in physical science have followed from the time of Faraday, methods resulting in the enormous developments in science that have taken place in modern times. In those days I was immensely impressed by Sir William Armstrong's mechanical genius, the layout of his experiments, and his judicious selection of the fittest; and, perhaps above all, by his extraordinary attention to minute details in critical cases of difficulty, while ordinary general administration he deputed to others. When he was busy with a difficult problem he concentrated his attention on it alone, and his powers of mechanical diagnosis were truly remarkable. I picture him as the cleverest mechanical engineer I have ever known. In later years, in my own business, I have endeavored to follow the same methods and principles, and have had many more failures than successes, numerically speaking, in the effort to progress as my teachers had done before me; yet the failures should have been soon discerned, and effort concentrated on the successes."

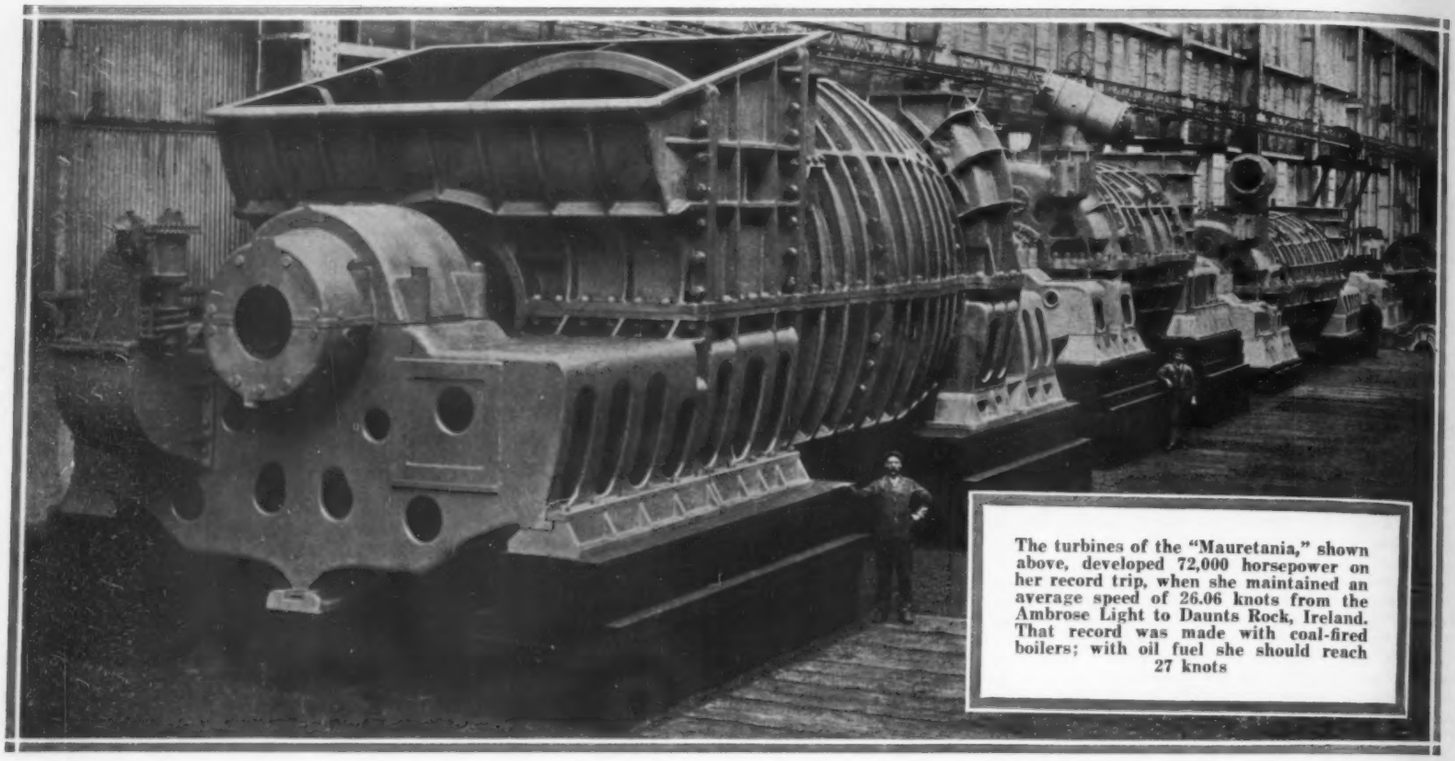


The Inward, Radial-Flow Turbine of 1890, experimental type, later discarded for the parallel-flow

His term of apprenticeship over, he took an appointment with Kitsons, of Leeds, for whom he built many of the epicycloidal engines referred to above. Before this period, however, his thoughts had already turned to the possibility of designing a steam turbine that for certain classes of work would rival if not surpass the reciprocating engine in efficient and economical running. The idea was, of course, not new. The first turbine of which we have any record was Hero's reaction steam wheel, made at Alexandria 2000 years ago. This ancient device was revived in 1837 by one Avery, of Syracuse, New York, who employed it to drive a circular saw, and at the same date steam wheels were in use in Scotland for working cotton gins.

Parsons, who knew all about these early machines, recognized their deficiencies and determined to approach the problem from an entirely new angle. His knowledge of hydraulics convinced him that without moderate surface velocities and speeds of rotation a thoroughly effective turbine motor could not be developed, and therefore, he says, "I decided to split up the fall in pressure of steam into small fractional expansions over a large number of turbines in series, so that the velocity of the steam nowhere should be great. This principle of compounding turbines in series is now always used in all save very small installations, where steam economy is not a prime consideration. It appeared to me, also, that by arranging small drops in pressure at each turbine I should be more sure of gaining a high efficiency, because then the steam would flow, practically in a non-expansive manner through each individual turbine, in a way analogous to that of water in hydraulic turbines, which were known at that date to be highly efficient."

Toward the end of 1883 Parsons became a junior partner in a Gateshead firm, and at once proceeded to put his ideas into practical shape. This he contrived to do so promptly that his first steam turbine was built in the following year. Of the parallel-flow type, it developed 6 horsepower, and was employed for driving a dynamo; in which capacity it proved more than successful enough to justify the inventor in continuing his line of research. After being used for some years this engine was presented to the Science Museum, London, where it now reposes in company with other remarkable inventions of the mechanical era. Encouraged by this initial success, Parsons next designed and built a compound steam turbine of 10 horsepower, running at 18,000 revolutions per minute. This, too, was intended for electrical generation, the inventor having meanwhile designed and patented a dynamo that would run at the high speed corresponding to that of the turbine rotor. Turbo-electric plants of this type soon came into great favor, and to that extent the success of the system was already assured. But Parsons was anxious to apply it experimentally to ship propulsion, an idea which he had already elaborated in a patent specification filed in 1884. The realization of the plan had to be postponed, however, for several reasons, one of them being a dissolution of partnership that occurred in 1889, whereby the inventor was deprived of the proprietary rights in his own patents and thus compelled to forego the further construction of turbines on the parallel-flow system, which was known to be the best and most efficient. So far from discouraging him, however, this check only served to direct his inventive genius into other channels. Establishing his own works at Heaton in 1890, he built experimental turbines on the radial-flow principle, succeeding after



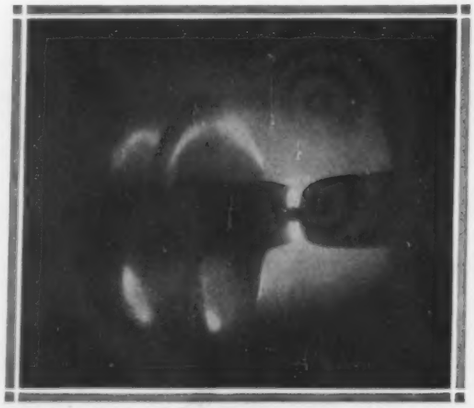
The turbines of the "Mauretania," shown above, developed 72,000 horsepower on her record trip, when she maintained an average speed of 26.06 knots from the Ambrose Light to Daunts Rock, Ireland. That record was made with coal-fired boilers; with oil fuel she should reach 27 knots

some difficulty in producing and marketing a satisfactory turbo-electric plant on this system. Throughout those five years in which he was debarred from exploiting his original patents he was continually experimenting with new ideas, all bearing on the efficiency of various elements in the steam turbine, particularly the blading; and when, in 1894, he recovered his patent rights, the fruits of his indefatigable research work soon became manifest. The manufacture of parallel-flow turbines was at once undertaken at the Heaton factory, one of the first contracts executed being for a 350-kilowatt turbo-generator set, which in those days was considered a plant of enormous power.

"From the first," said Sir Charles, "I realized the possibilities of turbine propulsion for ships, and had devoted much study to the problem, but I was not blind to the special difficulties which stood in the way, notably that of finding a propeller that would work efficiently at the high rate of revolution necessitated by turbine drive. In 1894 I began experimenting with small ship models in a pond at my home at Ryton-on-Tyne, to determine, first, the ship lines best adapted to very high speeds, and next to study propeller action. One of these models, two feet in length, was fitted with clockwork and a twisted rubber cord actuating a two-bladed propeller, which turned at 18,000 revolutions per minute and drove the boat at a speed of six knots. Other models followed, and eventually we were able to calculate the propeller efficiency required for a full-size turbine steamboat. At this stage a syndicate was formed for the building of the vessel which afterward became widely noted as the 'Turbinia.' The hull was 100 feet long, 9 feet broad, and drew 3 feet of water on a displacement of 44 tons. She had one double-ended straight-tube boiler, supplying steam to a turbine of the radial-flow pattern, which was coupled to a single propeller shaft. The trials began in 1894, and various sizes and types of propeller were tried, both singly and in multiple, until we found that three screws set on the same shaft gave the best performance. The highest speed attained, however, was only 19¾ knots, with which I was by no means satisfied. Eventually the disappointing result was traced to cavitation, a phenomenon that we were able to study very closely with the aid of a special apparatus and instantaneous photography. The outcome of these experiments was a decision to reequip the 'Turbinia' with three sets of turbines—built this time on the parallel-flow system—and to set three propellers on each shaft, or nine in all. The new engines weighed only 3 tons 13 cwts., the total weight of the plant, with boiler, shafting, propellers, etc., amounting to some 22 tons, while the horsepower developed was about 2000 units. This time the results were far more promising. Many trial runs were made at all ranges of speed, the maximum reached being nearly 33 knots. Not only this, but the installation proved both economical in steam consumption and handy to manipulate, it being possible to work up to top speed in much less time than would have been necessary with reciprocating engines. Another gratifying feature of the tests was the absence of vibration."

Mr. Parsons—whose knighthood dates from 1911—now decided that the time had come to confound the skeptics who still disbelieved in the new system, and the great naval review held at Spithead in 1897 to celebrate the Diamond Jubilee of Queen Victoria afforded a particularly favorable opportunity for demonstrating the "Turbinia's" powers. Accordingly, the little vessel was quietly steamed down to Cowes roadstead to await the psychological moment. It came when the great fleet of British and foreign warships lay at anchor in several long lines, with royalties and other distinguished personages from the four quarters of the globe looking on. Suddenly, at the head of one line, there flashed into view a diminutive vessel traveling at incredible speed. Down the long lane of motionless leviathans she shot like an arrow, only a wisp of smoke at her squat funnel, her forefoot well clear of the water and her wake a tumbling rampart of foam that testified to the marvelous speed at which she was moving. Doubling like a hare round the head of the column, she sped between the next line of ships at the same amazing velocity—it was actually 34 knots—and was gone before the onlookers had time to grasp the significance of what they had seen.

"I have a vivid recollection of that day," said Sir Charles, "having myself acted as chief engineer during the run. Some hours after we had returned to our moorings a message came from Prince Henry of Prussia, the Kaiser's brother, asking if I would repeat the run as a personal favor to him. We had visitors, including ladies, on board at the time, and were not prepared for another cruise at such short notice, but there was no help for it and I gave the necessary orders. In a few minutes we were off again, racing merrily over the course at 34 knots. It seems that Prince Henry was much impressed, for he sent his engineer officers across to inspect the 'Turbinia,' which they did with characteristic German thoroughness."



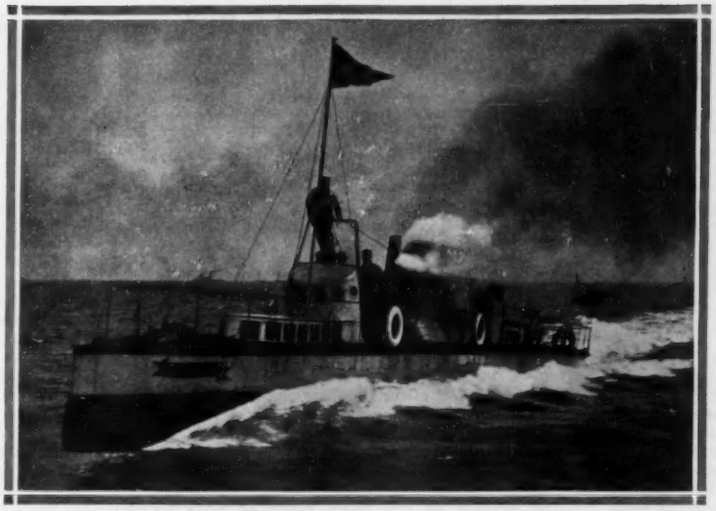
Photograph showing cavitation. The whitish arcs are the air spaces of cavitation, formed back of the propeller blades, which cause great loss of power

After this dramatic display of what the new method of propulsion could do, the British Admiralty deemed it time to avail themselves of the inventor's genius. They therefore ordered a destroyer to be built and equipped with turbine engines, but placed the entire responsibility for the result on Mr. Parsons' shoulders. The "Viper," which was thus the first turbine-driven warship in the world, was 210 feet long by 21 feet beam and displaced 370 tons. The contract called for a guaranteed speed of 31 knots. The "Viper's" trials resulted in a complete triumph for the new motor. Her fastest run was made at a speed of no less than 37.113 knots, the turbines developing 12,300 horsepower. The "Cobra," a similar but slightly larger destroyer, was built at about the same time, and she, too, attained a very high speed. By a most unfortunate mischance, however, both vessels were lost soon after they had been completed—the "Viper" in August, 1901, by running ashore during maneuvers, and the "Cobra" in the following month by foundering in a North Sea gale with great loss of life. Although neither was due in any respect to the turbines, the effect of these two disasters was to damp the enthusiasm of the naval authorities, and several years passed before a new turbine-driven man-of-war was ordered. Merchant shipowners proved equally conservative. The inventor himself was confident that turbine machinery was particularly well suited for high-speed mercantile ships, such as cross-Channel boats and Atlantic liners. Its adoption would, he predicted, effect a reduction in weight of machinery and an increased economy of fuel. Finally, as no shipping firm seemed disposed to take the first step, Mr. Parsons' own firm cooperated with Messrs. Denny, of Dumbarton, and several gentlemen interested in the system, in building a turbine steamer for passenger service on the Clyde Estuary. This vessel, the "King Edward," was built in 1901. She soon asserted her superiority over the paddle steamers engaged on the same route, and her success at last induced the South Eastern Railway Company to order the first turbine steamer for the cross-Channel service between Dover and Calais. "The Queen," as this ship was named, more than realized expectations as to speed, economy, and general efficiency. The ice having thus been broken, orders for other turbine vessels, mainly cross-

Channel boats and private yachts, began to flow in. The first large ocean-going ship to be fitted with turbines was completed in 1904, and in the same year the Allan Line ordered two transatlantic liners, "Virginian" and "Victorian," to be engined on the same principle. Twelve months later Mr. Parsons had the gratification of learning that the Cunard Company had decided to install his system of propulsion in the twin ocean giants, "Mauretania" and "Lusitania."

Meanwhile, however, the turbine was making equally rapid progress in the naval sphere. When, in 1902, the Admiralty laid down four light cruisers of identical design, they ordered one ship, the "Amethyst," to be equipped with turbines, her three sisters having reciprocating engines. When comparative trials were held, the superiority of the "Amethyst" was demonstrated so conclusively—she attained 23.63 knots, while the maximum speed of the other three was 22.34 knots—that the committee which had assembled to determine the characteristics of the Dreadnought recommended that turbine machinery be adopted for the world's first all-big-gun battleship. From that time onward the turbine became the standard motor of the British Navy, and other admiralties soon fell into line. In view of all that has been heard of German enterprise, it is interesting to recall that German marine engineers were bitterly opposed to the introduction of the turbine into their navy, and did not abate their hostility until repeated trials had left no doubt in reasonable minds as to the marked and all-round superiority of the new system for naval purposes. Of the subsequent history of the steam turbine it is unnecessary to speak here. Even before the war it had completely ousted the reciprocating engine in the navies of the world and was being almost universally adopted for the larger types of merchant vessels. Today its supremacy in the steam world is unchallenged, though there are indications that the internal-combustion engine will eventually become a serious rival.

The author of this outstanding achievement in the annals of engineering progress is a quiet and unassuming gentleman, who shows signs of embarrassment when you speak of his work in glowing terms. In conversation with him one gets the impression that here is a great workman to whom work is not the means to an end, but an end in itself. Notwithstanding a life of study and untiring industry, he retains all the enthusiasm of youth, together with a simple kindliness of manner and an old-world courtesy that endears him to all with whom he comes into contact. To Sir Charles Parsons there are few higher vocations in life than those of the scientist and the improver of arts and manufactures. Here, in his own words, are his views on the subject: "Can it be questioned that the discoveries of Archimedes and his disciples have more effect today than the battles of Alexander or of Hannibal? Of, if we turn to modern times, can it be gainsaid that Watt and Stephenson, Davy and Faraday, have done more to change the course of history and the material conditions of life than did Napoleon or Wellington, Walpole or Pitt? No less a statesman than the late Lord Salisbury once said, that while the work of the politician, the statesman, the soldier, or the leader of men, however great and however fortunate, is of necessity transitory—what is accomplished by one man being undone by another—the work of the scientific discoverer and inventor is everlasting. However insignificant this work may apparently be, provided it is new it adds something more to that great store of human knowledge and experience which is slowly accumulating and enables man more and more to triumph over nature."



Parsons built this little craft (100 ft. long, 2000 horsepower) to demonstrate his new marine turbine. This the "Turbinia" did by steaming through the British fleet at Spithead Review at 34 knots in 1897

Iron and Steel in Brazil

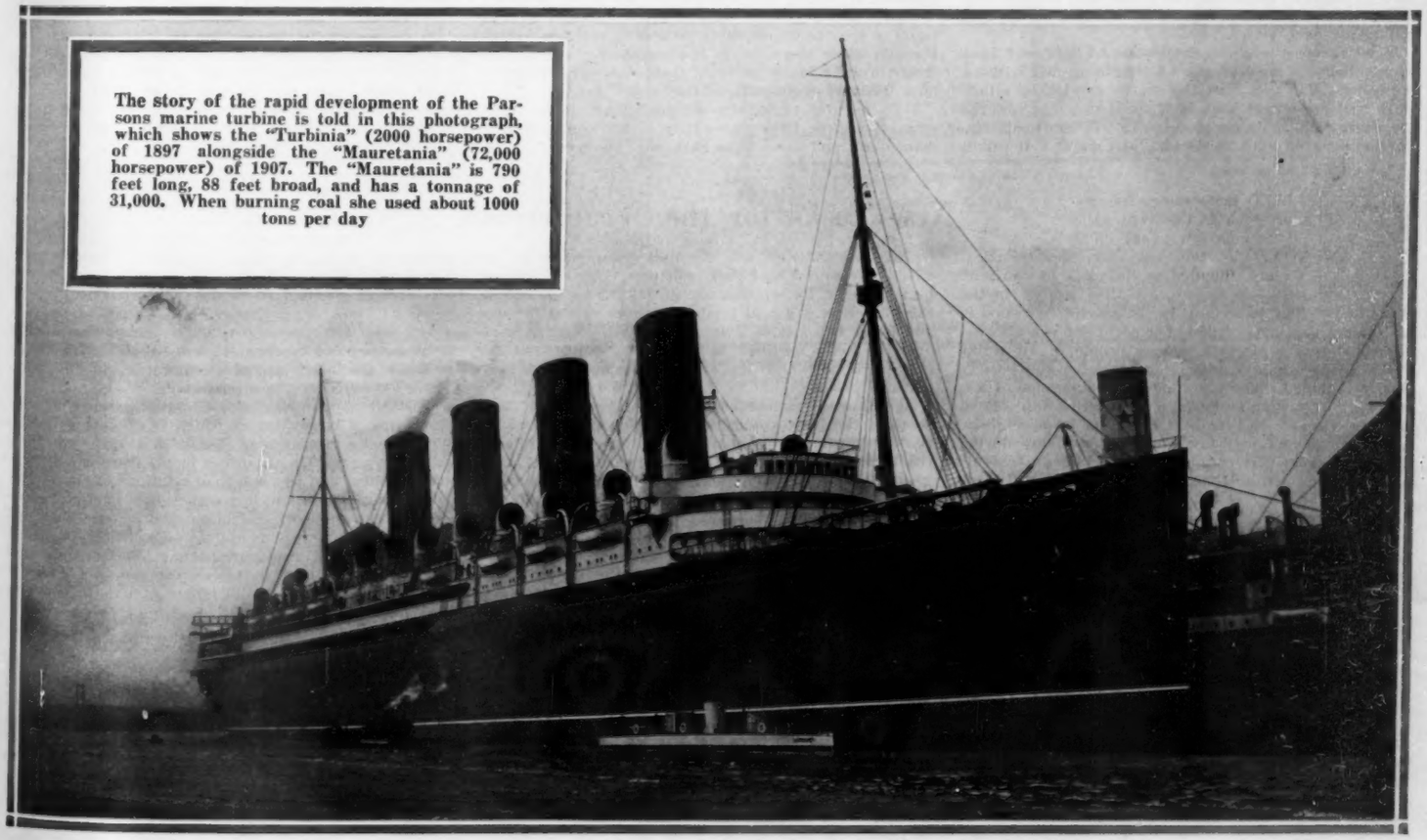
IMPORTANT developments in the national iron and steel industry have taken place in Brazil during the past year. These developments represent a phase of the Brazilian Government's policy to give the nation a greater degree of economic self-sufficiency by utilizing such resources as exist in the country. The object is to supply the home market for iron and steel and eventually to produce a surplus for export to other South American Republics.

Iron and steel manufactures are developing rapidly in Brazil, especially in Sao Paulo. The products of this industry include nails, screws and bolts, chains, woven fence wire, agricultural implements, enameled iron ware, rolling doors, safes, stoves, and a great variety of general foundry work.

The basis of the Brazilian industry is the vast stores of high-grade hematite and magnetite ore existing in Minas Geraes and to a lesser degree in several other States, including Sao Paulo and Parana. It has been estimated by competent geologists that the total ore content of these fields is between 6,000,000,000 and 12,000,000,000 tons of hematite, a very large proportion of which runs over 60 per cent iron. This is exclusive of the lesser volume of magnetite ores.

Both the present Federal Administration and the Governments of Minas and Sao Paulo have pursued a policy of encouraging the growth of an iron and steel industry. Liberal concessions have been granted to several companies, the principal favors consisting of exemption from import duties on equipment and from other taxes over a long period of years. Also, guaranties of substantial Government purchases have been given, and recently the policy has been adopted of making loans to metallurgical concerns.

The story of the rapid development of the Parsons marine turbine is told in this photograph, which shows the "Turbinia" (2000 horsepower) of 1897 alongside the "Mauretania" (72,000 horsepower) of 1907. The "Mauretania" is 790 feet long, 88 feet broad, and has a tonnage of 31,000. When burning coal she used about 1000 tons per day



What Is Cold Light?

By W. van B. Roberts
Princeton University

THE recent announcement that Professor E. N. Harvey of Princeton has succeeded in producing cold light makes it worth while to consider in some detail what the term "cold" means from the physical point of view when applied to light, and to inquire whether the production of such light is more interesting from the practical or the theoretical side.

Cold light has been called light without heat.

But when light of *any* sort falls upon matter, the temperature of the matter rises, although the rise may often be too small to notice. This fact might seem to preclude any possibility of "light without heat." However, when we have defined the term "heat" and "light" more rigorously the difficulty will be seen to be only a question of definition.

Energy traveling through empty space is called radiant energy, or simply radiation. In order to be able to picture this intangible flow in more familiar terms, we have conceived an invisible, all pervading medium and named it "the ether." Through this ether it is easy to imagine energy traveling in the form of wave motions. The longest ether waves in present use are about 15 miles from crest to crest, and are used for long distance wireless telegraphy. Radiophone broadcasting is being done on waves 360 meters, or less than a quarter of a mile, long. At the present time we have no practical use for waves shorter than 100 meters or so, until we come to very minute ones less than a thousandth of an inch in length. These we feel if they fall upon the skin and we call them "radiant heat." But if we consider still shorter waves about .000028" long, we find that the eye begins to detect them better than the skin and calls them "red light," and as the wave length gets less, the eye becomes a better and better detector of radiation until we reach about .00002 (greenish yellow light) which is the wave length for which the eye is most sensitive. If the wave length is reduced to less than about .000015" (violet light) the eye again becomes powerless to detect them. Waves too short to see are called "ultra violet," and the shortest waves in use are called X-rays, which may be less than a hundred millionth of an inch in length.

All the above mentioned waves are fundamentally the same: they are the mechanism we "make-believe" to carry energy across empty space. Any way that we separate them into classes will be arbitrary, though perhaps very easy. So let us take all the wave lengths that can be detected by the eye and call them light waves, or light. And take the waves that are too long to see but too short to consider as wireless waves, and call them "heat waves."

If we accept the above definitions of light and heat waves, there is no difficulty of imagining one without the other. The fact that the energy carried by either class will appear as heat in a substance that absorbs the energy has nothing to do with our arbitrary distinction between light waves and heat waves. It would perhaps be less confusing to use the terms "visible" and "subvisible" instead of light and heat when applied to ether waves.

The problem of efficient illumination is then to produce radiation that contains enough light for the purpose, and as little heat as possible, because the energy that must be supplied to produce the heat waves is a total loss as far as illumination goes.

Fire was probably the first artificial light, and it is only in recent years that we have improved upon some sort of open flame. And moreover, almost all modern methods are merely improvements rather than new methods. We still rely mainly on the fact that light is given off by sufficiently hot substances. To see what we can hope for along this line, let us review a few of the results of experiment.

First, a hot solid emits radiant energy in a wide assortment of wave lengths. Most of the energy however is carried by a comparatively select group of waves.

The location of this select group of wave lengths depends upon the temperature of the body. The higher the temperature, the shorter the waves that get the majority of the energy.

Thus it might seem that if we raise the temperature of the body high enough, we could reach a point where most of the energy radiated would be in the form of light waves. This reasoning is sound, but unfortunately we have not found any substance that will not melt or volatilize before the temperature is reached. With such substances as the tungsten wire used in incandescent lamps, the highest possible temperature is so low that the majority of the energy radiated is in the wave length region we have called heat. Thus we can appreciate that paradoxically enough, our advance by this method toward the goal of cold light has consisted in making the source hotter. For example, the advantage of gas filled incandescent lamps is that the filament can be run hotter—the gas is merely to keep the filament from volatilizing too quickly and blackening the inside of the bulb. We are so far short of the goal that the only reason that we are at all satisfied with our lights is because the eye requires so minute an amount of energy. It can detect 10^{-18} ergs. per second. To give an idea of such sensitiveness after the conventional manner, it would take the population of a thousand worlds like ours, each with a billion people, a time equal to the age of our earth, to absorb as much energy through their eyes as a one-horsepower engine delivers in one minute, provided their eyes were receiving only the very feebleST light they could detect.

It is natural to inquire whether there is no other way of creating light waves than by heating some substance up, and how it is that heating does it. The present theory is, roughly, that the light waves are splashed out in the ether by electrons vibrating in some sort of equilibrium in the atoms of the substance that is heated up. These vibrations are due somehow to the violent banging together of the atoms. And to say that its atoms are in a state of violent collision with each other is merely a fundamental way of saying that the substance is at a high temperature. If we take a piano as analogous to the atom, the strings of the piano correspond to the electrons. Suppose we are interested only in obtaining notes that lie somewhere between middle C and the octave above it. We could bang the piano violently against the floor and we would get the desired notes—as well as all the others. Getting light by heating a wire is about as efficient as getting certain notes by banging the whole piano. It reminds one of the essay by Charles Lamb, where the original discovery of roast pig is supposed to be due to the accidental burning down of a house that had a pig in it. The product was found so good that people began regularly to imprison pigs in houses and set fire to the houses.

Returning to the piano analogy, it is easy to say that we should reach in with some sort of hammer and hit only the string that gives the note we want. In the case of the atom the same scheme suggests itself, but the trouble is to find the instrument that will knock into vibration only those electrons whose vibrations send out light waves alone. But it is evidently exactly this which has been achieved by the firefly and artificially by Professor Harvey by the oxidation of luciferin. The bombardment of the molecules or atoms of a gas at low pressure by electrons is a purely mechanical attempt to get the same results, and glass tubes containing a little gas and working on this principle have been used successfully.

The development of a method of turning a large proportion of some other sort of energy into light energy is of great importance, but as yet the actual results are of theoretical rather than practical value. The light obtained from chemical energy by Professor Harvey is not of great brilliance: some thirty square inches of surface of his luminous solution are required to give one candlepower. And the present cost of producing a candlepower by this method is such that the interest charges on such an investment would be about fifty times the cost of ordinary electric light. The only way to make the luciferin lamps practical is to continue the experimental work, and in particular to try to synthesize the luciferin, and thus perhaps get it in commercial quantity instead of the tiny experimental amounts now only available from animals.

In conclusion, it will be well to deny definitely that the luciferin lamp is a perpetual-motion machine. Energy has to be supplied in order to keep it going. Light is produced when the luciferin is oxidized. Then instead of putting in more fresh luciferin, the resulting oxyluciferin is reduced to its original condition by the proper agent, to be used again and again.

New Tasks for the Weatherman

APPLIED meteorology has notably come to the front within the past few years. The history of the American Meteorological Society, founded at the close of the year 1919, serves to prove that interest in the study of weather, especially in its practical aspects, is not limited to a little group of experts and a scattering of hobbyists, but prevails among people in all walks of life. One of the significant acts of the new society was to organize committees for the furtherance of meteorology in particular fields, chiefly utilitarian. Each of these already has its literature and its specialists.

Military meteorology first rose to importance during the World War. It can hardly be listed as "useful" without some qualifications, but that it is in full vigor is attested by the fact that professional meteorologists are now attached to most armies and navies, including those of the United States.

Marine meteorology is not a novelty, dating back to the late Matthew Fontaine Maury, of the United States Navy, some time before the American Civil War. It has, however, undergone recent improvements, chiefly owing to the rise of radiotelegraphy. Ships at sea now contribute their quota of information to the daily weather map of the landsman, and receive copious data by means of which shipboard weather maps can be drawn.

Agricultural meteorology had its pioneers of a century or more ago, but it is so new as a distinct and coherent body of knowledge that the first comrehensive treatise on it in any language appeared less than two years ago. A flood of light has lately been shed upon such matters as the "critical periods" of growth, during which various crops are especially susceptible to the effects of temperature and moisture. There is reason to hope that the application of knowledge gained in this direction will add to the earnings of the farmers and lower the cost of living for the rest of us. Moreover, it seems destined to provide a sound basis for crop predictions and thus stabilize the market for agricultural products.

Aeronautical meteorology has so far "arrived" that some of the large companies operating commercial air routes maintain their own weather bureaus; while all the official meteorological services of the world have greatly enlarged their activities in behalf of aeronautics. Aeronautical meteorology is a twofold subject; on the one hand aircraft (balloons, kites, and, of late, airplanes) are systematically employed for obtaining meteorological information, and on the other meteorology is deeply engrossed in the task of safeguarding and facilitating aerial traffic. The future of aeronautics is bound up with the development of this branch of applied meteorology.

Hydrological meteorology has become conspicuous in the field of engineering. The two leading textbooks of hydrology recently published in this country are valuable contributions to meteorology, and the most elaborate study of storm rainfall hitherto made anywhere in the world was that carried out not long since by the engineers of the Miami Conservancy District.

Since weather is a vital factor in many lines of business, and an important one in nearly all, a prosperous career awaits the commercial meteorologist; and in a sporadic way he is already plying his profession. Neglect of the forecasts means ill-timed advertising, the exposure of perishable goods to adverse weather conditions, and other more or less obvious consequences of meteorological unpreparedness. The study of the world's climatic statistics should be a part of any campaign for capturing new markets; the preparation of a comprehensive treatise on this subject in English is perhaps the most urgent desideratum in the whole range of scientific literature.

Medical meteorology and climatology have a bulky literature, a large part of which is of dubious utility. The climatic treatment of disease is a well-worn theme of controversy. On the other hand, there are medical, physiological and psychological relations of meteorology concerning which much positive information has recently been gained. The atmospheric conditions that affect the comfort of mankind and influence the output of physical and mental labor are better understood than they were even half a decade ago, and a number of specialists are devoting their efforts to obtaining more light on this subject.

A Color Test for "Remade Milk and Cream"

A PRACTICAL qualitative test for distinguishing natural pasteurized milk from a mixture of natural and remade milk has been devised. This test is based upon the discovery that a yellow color is produced when the worked curd of milk made from milk powder is treated with sodium hydroxid. The color is probably due to the combination of a trace of lactose with the protein during the process of manufacturing the milk powder.—O. L. Evenson in *Journal of Dairy Science*, 1922: 97.

A Candidate for the British-American Cup Contest

ALTHOUGH it is unlikely that there will be any contest for the America's cup for many years to come, if ever, this does not mean that international yacht racing between America and her long-time competitor, Great Britain, is over. In the seventy years, more or less, which have intervened since the "America" made her famous bid for victory off the Isle of Wight, the racing for the famous trophy has been confined to large and costly yachts, and therefore the sport has been of necessity a rich man's game. Today, however, when the indulgence in yachting has been so greatly extended, and when the younger men have taken to the sport in such large numbers and have shown so much aptitude, international racing has ceased to be confined to the big yachts; and some of the very finest contests on record have been held between little craft, measuring from 18 to 23 feet on the waterline.

This year's contest will be the second to be held for the British-American cup for 6-meter yachts. We sent over several boats last year, but were beaten. This year the British are coming across to try their luck against us in our own waters.

It is true in the small classes of yachts as in the big, that when the designers have done their best and the owners have put their last ounce of energy and knowledge into the tuning up of their boats, a large element of uncertainty is thrown into the contest by the weather. Between the racing waters of the United States and Great Britain there is this broad difference: The British yachts sail in heavier and stronger breezes and in more broken water; while over our summer courses in America the winds are not so heavy and the seas are smoother. These meteorological conditions have left their stamp upon the yachts of the respective nations. Of two yachts built by the same rule you will find generally that the English boat is more heavily built, has more displacement, and carries less sail than her American competitor.

Through the courtesy of Mr. H. J. Gielow we are enabled to present some drawings and a photograph of the "Lea," which he has designed as a competitor in this year's races for the cup. She is built strictly to the international rule. As Mr. Gielow says: "This boat represents an honest attempt to build the best possible boat under the rules of the International Yacht Racing Union." So far as the hull is concerned, the rule takes account of the girth, both amidships and at each end of the waterline. Also, the rule encourages the designer to give his yacht ample freeboard. The effect of the rule will be noticeable in the outboard profile and deck plan. The restriction upon girth at the ends of the waterline accounts for the sharpness of the stern as seen in the deck plan.

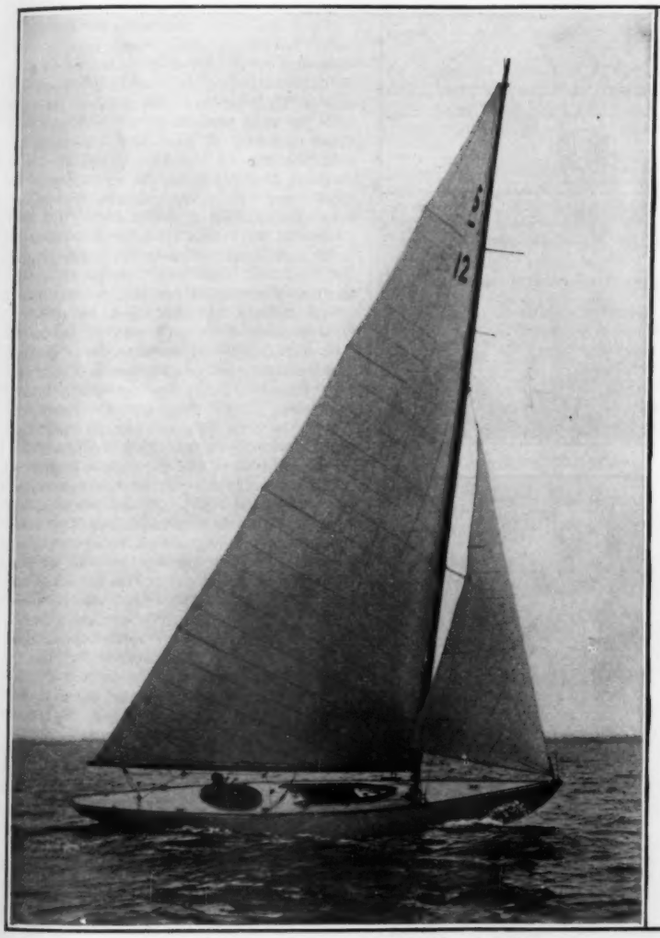
The most interesting part of the hull of this vessel lies, as usual, below the waterline. The close following of the rule has produced a midship section which looks more British or Continental than it does American. That is to say, the beam is very moderate, and unlike the pronounced or "hard" bilges, and the shallowness at the garboards, with which we are familiar on this side of the water, Mr. Gielow's model shows an extremely easy bilge and full garboards. Speaking broadly and in a rather loose way, it may be said that this little boat comes midway between the old "plank-on-edge" cutter of the "Genesta" type and the extreme scow-fin type, as represented by the "Reliance." Among the later America's cup yachts, the little "Lea" is more like the "Resolute" than any other competitor, English or American. She belongs very definitely to the class of so-called "wedge-shaped" models.

When we saw this boat, just before her launching at Jacob's Yard, we predicted that the lighter the winds, the greater the margin by which the "Lea" would win over her competitors; and this prediction has been rather fully verified. Her good light-weather performance is due to the fact that a model of this type has a relatively small wetted surface, and in light winds, when the speed is low and wave-making is practically non-existent, the resistance of the hulls is in close proportion to the amount of wetted surface. In a strong wind, like the old-time cutters, we should expect her to heel rather quickly, and then show satisfactory stiffness as her upper body became immersed.

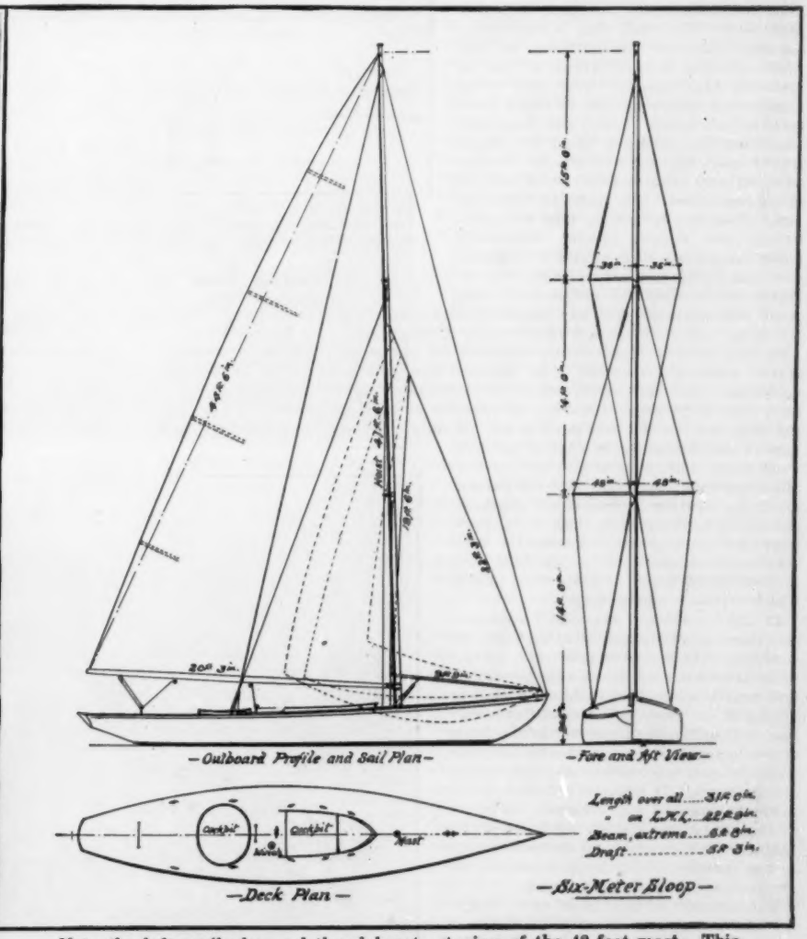
All of the boats, both British and American, will carry what is known as the Marconi rig, in which the sail plan shows exaggerated height for its base. In the case of the "Lea" the base is only 30 feet, whereas the height is 41 feet 6 inches. Everything about the boat is amazingly light, especially her rigging. Thus, her 41½ feet of mast measures only 4½ inches in diameter at its thickest part. To keep the mast in place a system of trussing is arranged and the stresses in the struts and wire ropes are calculated very much as they would be for a bridge or a framed roof. There is a single gib whose stay carries about one-third of the way up the mast. The great loftiness of the rig is justified both by experience and by science. In an airplane it is the length of the leading edge that counts; that is to say, within reasonable limits the long narrow wing will give better efficiency than the short and deep one. So, in the aerodynamics of the yacht, it is found that the tall narrow rig has more driving power than a low broad rig of the same area.

The length of the "Lea" on deck is 31 feet, and on the waterline, 22 feet 9 inches. The beam is unusually narrow, being only 6 feet 8 inches, and the draft is 5 feet 3 inches. The frames measure 1⅛ by 13/16. The sheathing is one-half inch thick. The standing gear is of extraordinary lightness. In order to save weight and windage, a wire rope was made of a special steel alloy with a tensile strength of 180,000 pounds to the square inch, with the result that all this gear weighs something less than 100 pounds.

In the elimination contests on this side of the water, there will be entered fourteen new American boats built this year, and two of last year's boats that competed in British waters. For the English elimination contests are thirteen of last year's boats and six built this year. As a result of these contests, a selection will be made of four American and four English boats. These, late in the season, will meet in five or six races, when the winning boat will be determined by points. Thus, the winner will be given one point for starting in the race, and one point for each boat which she beats out of her seven competitors. This method of scoring should give a very true line on the respective ability of the contestants.



The "Lea," a promising contender in the elimination races to select four boats to defend the British-American Cup



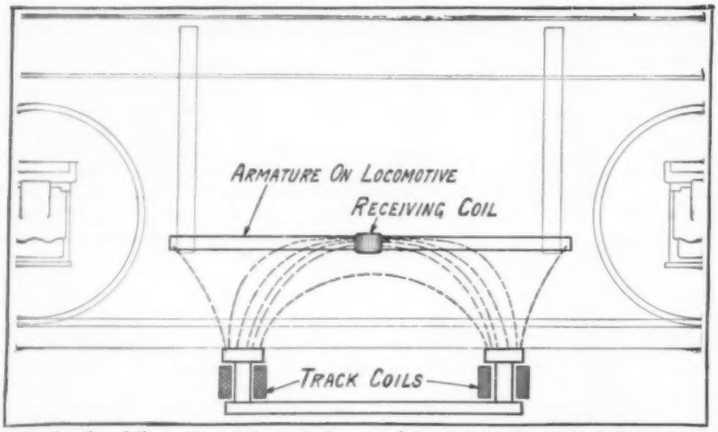
Note the lofty sail plan and the elaborate staying of the 42-foot mast. This is known as the Marconi rig. It gives greater driving power for same sail area than the old gaff rig

The Electro-Magnet at the Throttle

Details of Still Another Type of Automatic Train Control Now Being Developed

By Charles W. Burrows, Ph.D.

AUTOMATIC block signaling has been in use on the railroads of this country for over twenty years and has been developed to a very high state of perfection; likewise, the control of the train by means of the present air-brake system has reached a high state of perfection. In other words, the wayside signals are as nearly perfect as human ingenuity and mechanical skill can make them, and the train mechanism has an equal degree of perfection. The weak link is the human element; most of the collisions on railroads are due to the failure of the engineer to obey signals. The work of the engineer is strenuous and at times nerve racking; his hours of duty are frequently long, and his attention must be concentrated upon the wayside signals, as well as upon any train orders which may be in his possession. The engineer, like other men, is subject to fatigue and weariness, illness and sudden death. Automatic train control has been proposed to compel obedience to the indications of the wayside signal and to meet the exigencies arising when the engineer, for any reason whatsoever, fails to operate his train in accordance with instructions.



Showing the relative position of the track element and the receiving element on the locomotive. The dotted lines represent the flow of magnetic energy. The track element is buried under the ties midway between the rails and not directly under one of the rails, as might appear from this drawing

The electromagnetic brain of the automatic train control system

In the present stage of development of automatic train control the problem is to regulate the train in accordance with the indications of the wayside signals; such control, however, must not be effective as long as the engineer is alert and performing his duty. Inventors of automatic train control methods must keep their hands off the present block system of signaling and the present air-brake system. Competent engineers have been working upon these latter problems for many years. Automatic train control, therefore, has its specified field of activity in which it may work and to which it must confine itself.

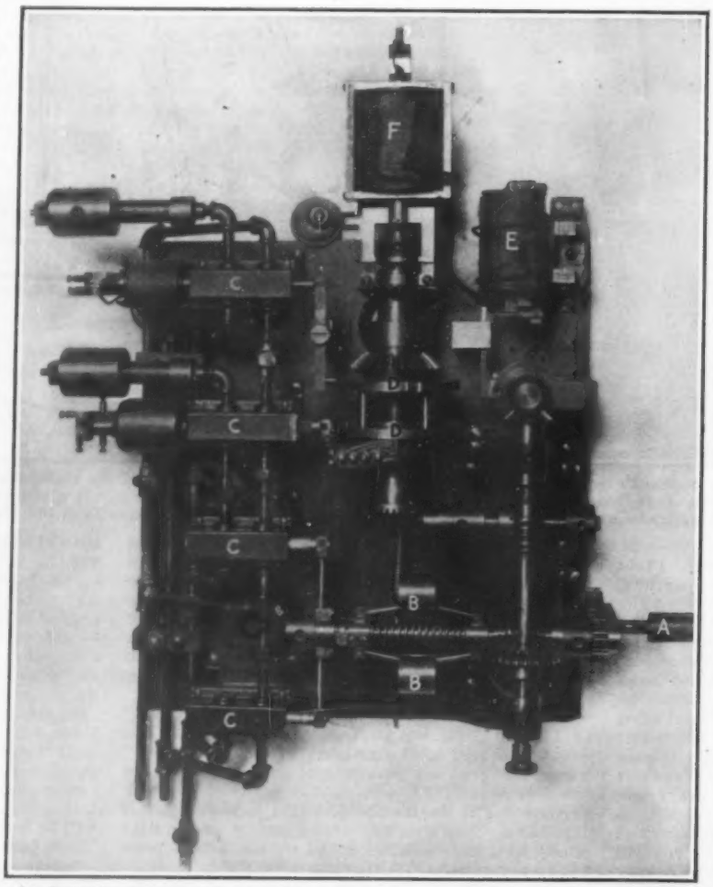
In any system of automatic train control there is an element situated upon the roadway, which is brought into contact with an element on the moving locomotive and either brings the train to a stop or allows it to proceed, as conditions warrant. This roadway element is the brain of the system. It has perceptive facilities which keep it informed of any obstruction on the track. It sends a pulse of energy to the locomotive, which causes the action of the air brakes just as the brain of the engineer sends a pulse of nervous energy to the muscles of his hand when the engineer himself applies the brakes.

The perceptive faculty of this "brain" is substantially the same in all types of train stop. It is in the transmission of the pulse of energy necessary to initiate the braking action that the various systems differ. In the earliest system a projection on the ground strikes a lever mounted on the locomotive. This was discarded except for use in tunnels. The violent concussion is liable to break the moving parts; frost, rust and obstructions may lock them so that the action is unreliable. Because of these vital objections all moving parts were eliminated and an electrical contact system was devised. In this system a shoe carried by the locomotive slides over a "ramp" rail fixed to the roadway at intervals. Even this system, with its many merits, will fail to work when a heavy hoarfrost or much rust and dirt cover the ramp. The "shoe" hanging down from the locomotive may be broken by the blow of the ramp or of an accidental obstruction. The ramp itself projecting above the ground, as it must, is a source of danger to persons walking on the roadway. These objections have been emphasized by the Interstate Commerce Commission and by railroad engineers.

The objections just noted are overcome completely by the utilization of electromagnetic forces. Magnetic energy is independent of storm and sleet, offers no obstruction to the movement of mechanical parts, and can be transmitted from the roadway to the moving locomotive without any intermediate mechanical connection. The ideal track element, therefore, for any system of automatic train control must have an "electromagnetic brain." In practice this "electromagnetic brain" may be a wire parallel to the track, magnets embedded in the roadway, masses of iron on the track, or other similar devices.

I have spent considerable time in the investigation of the possibilities of a system using electromagnets buried in the roadway and will describe some of its details.

The track elements consist of two normally de-energized electromagnets of the horseshoe type controlled by the operation of an established automatic block-signal system. They are installed between the ties with the yoke parallel to the rails and the upper surface of the pole pieces flush with the top of the ties. One of these magnets is located at the entrance of a block, and the other magnet is located near the middle of the block. They are connected in series, and control through front and back contacts of track relays the "caution" and "stop" elements of the engine apparatus in conformity with indications of wayside signals. If the block in advance is clear, the electromagnet at the entrance of the block to be occupied is energized, and an impulse is picked up by the engine receiving-coil which resets a portion of the brake-control apparatus, and no automatic brake application takes place. The electromagnet is energized by a current from the pole line passing through the front contact of the track relay of the block in advance and through a back contact of the track relay of the block just entered by the train. If the block in advance of this is occupied, the track relay for the advance block is de-energized, and both track magnets in rear of the occupied block. The first track magnet encountered being dead, no impulse is transmitted to the engine receiving-coil; but if the speed is above a predetermined "caution" rate, a light service reduction is made by a device which operates until the speed is properly reduced. If the block in advance is still occupied when the train reaches the second track magnet, located near the middle of the block, this magnet also will be dead, and a full service application of the brakes will occur.



A.: Connection to locomotive axle. *B.B.*: Governor controlling valves *C.C.* *C.C.*: Air valves operating train brake. *D.D.*: Cams controlling valves *C.C.* *E.*: Magnet relay. *F.*: Reset magnet which withdraws cams *D.D.*

The cab mechanism of the automatic train control system

There are two air-valve operating cams mounted loosely upon a shaft which is continuously rotated by means of a mechanical connection with the engine axle. The cams are driven clockwise by a geared member normally engaged by a clutch keyed to the driven shaft and free to move in a vertical plane. When the clutch magnet is energized, the clutch moves upward, and becomes disengaged from the driven shaft and from the geared member of the cams. A helical spring returns the cams to normal position with counter-clockwise motion. When the clutch magnet is de-energised, the clutch member drops by gravity and engages the geared cam. This in turn is engaged by the driven shaft so that the same cams are again rotated clockwise, beginning another cycle of operations. The speed governor is also driven by the engine axle. It controls two systems of air valves, one for action between "caution" speed and the maximum speed, and the second for action when maximum speed is exceeded.

The complete system of the Raritan River Railroad is being equipped with this train control. The first public demonstration was made on December 15, 1921, and was a complete success, the appropriate stops being made with the throttle wide open and a full boiler pressure of 180 pounds.

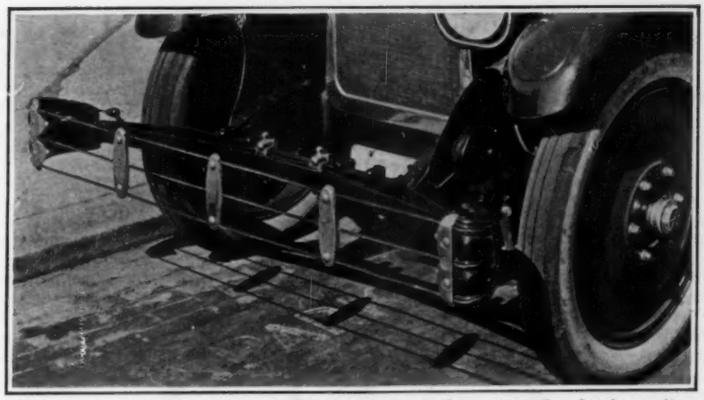
The Automatic Collision-Dodger

A NEW automatic brake control, ignition cut-off and horn-blower for both passenger automobiles and motor trucks has been patented by a San Francisco inventor, and is being manufactured in Oakland. As illustrated in the accompanying photograph, the device has the appearance, externally, of a bumper, yet is not a bumper in that instead of protecting only the car on which it is placed, it protects the other fellow's car and the pedestrian as well. Briefly, the invention consists in several, usually three, flexible contact bars, or cables, as the owner prefers, stretched between goosenecks attached to each axle, in the front and in the rear of the car.

These contact bars yield to pressures as low as fifteen pounds, moving inward about three-quarters of an inch, and making electrical connections which instantaneously set the brakes, cut off the ignition and blow the horn, the latter continuing to blow and the brakes to remain set until the pressure is removed. Cutting off the ignition, of course, adds to the braking power by the force of compression in the motor, and also eliminates danger of fire after the accident. When not in use the internal mechanism of the control rides as a brass cylinder on the brake rod, without interfering with the operation of foot or hand brakes. Long-continued experiments, carried on through the two years in which the inventor has been developing his patents, have shown that complete stoppage of a passenger car is made by this automatic device in one-third of the time and one-half of the distance required by the most skilled of drivers to throw in their brakes and cut off ignition.

This great speed is a decisive advantage, since lives and property frequently depend on fractions of seconds in automobile accidents. While the device operates automatically, whenever the contact bars touch anything with a pressure of fifteen pounds, yet the entire mechanism can be set in operation by the simple pressure of a single button located on the dashboard. Thus the driver, seeing himself being rushed into an accident, or a bewildered pedestrian in his way, can stop his car by this means whole seconds before he could have stopped it with foot or hand brakes. When the car is parked the brakes, of course, are set and ignition is cut off, but the automatic control sounds the horn immediately if anything touches the contact bars or cables, and there is no excuse for the careless driver who neither sees the standing car nor hears its horn.

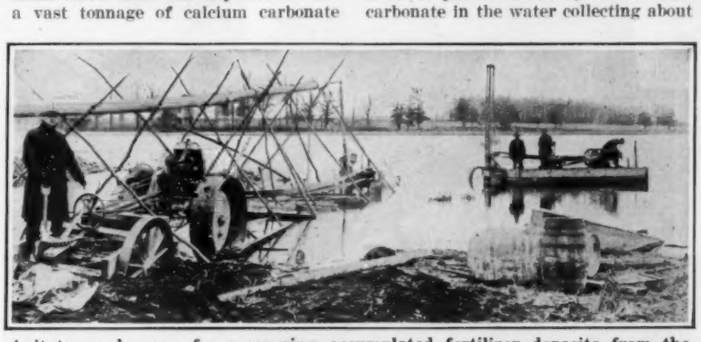
An advantage claimed for the new equipment is that when a pedestrian is hit, even though knocked down, the force of the blow is minimized by the resiliency of the contact bars or cables. When knocked down the pedestrian is in little danger of being run over, because the control already has stopped the car. It is also claimed that this same resiliency in the contact bars results in greatly reduced damage to cars into which they bump, or which bump into them, far less than the ordinary hard-steel fender now causes. Insurance companies are pleased with the cutting off of the ignition, and the resultant removal of the danger of fire, and the police have expressed themselves as pleased through the fact that the careless or heartless driver who hits a pedestrian, if his car be equipped with this control, cannot speed on until he has cut off the control, which stopped him at the second his car hit the man or woman injured.



A pressure of fifteen pounds on this wire bumper throws out the clutch, applies the brakes, cuts off the ignition, and blows the horn

A Successful Marl Pump

DOTTED here and there over the country, sometimes thick and sometimes thin, are inland lakes. For years people who have made a scientific study of agriculture, and especially crop production, have known that the addition of calcium carbonate (lime) to the soil will improve the crops on that soil. It has also lately been learned that these inland lakes have been the depositories for a vast tonnage of calcium carbonate deep bed, ranging from two to thirty feet deep. In some lakes it is in the form of pebbles made by the calcium carbonate in the water collecting about which originally was in the soil and which, being easily soluble, has washed down into these inland lakes. Here it stands, usually in the form of a mussel shell. This is a rather uncommon form. This marl analyzes all the way from 25 to 92 per cent acid-neutralizing equivalent, and requires little or no further treatment to put it in shape for application to the soil.



Agitator and pump for recovering accumulated fertilizer deposits from the beds of inland lakes

A pile of marl 50 inches deep and 150 by 47 feet, all pumped out of one small lake

Many devices have been tried in an effort to get this marl out on to the land, where it would dry and thus become available for plant growth. The diaphragm pump has been used with small success, as it only sucked the fine soft layer from the surface of the marl bed, but did not get the thick material below, which is usually quite cheesy. Also the dipper or steam shovel has been used, but this leaves the marl in bad shape for use and the large pieces must be crushed.

J. F. Carnes of Calhoun County, Michigan, has combined the diaphragm pump with an agitator in such a way as to make a successful marl pump. The indications are that this outfit will be able to deliver marl on dry land in such quantities that it can be sold at a price which will make it unprofitable for local farmers to do without it. The pump is operated by a tractor or other light gas engine. Any power which will drive it at 200 revolutions per minute should be sufficient. The intake to the pump is three inches in diameter, while the delivery pipe is two and a half inches in diameter. To the end of the delivery pipe a piece of hose is attached which makes it possible to shift the point of delivery after a mound of marl has accumulated.

The water charged with marl is pumped on to solid ground and is caused to precipitate by a series of dykes which makes the water take a long winding route before it gets back into the lake. During this route a large part of the marl is thrown down. When the pumping first commences, the dykes must be made out of soil, but as the marl accumulates the dykes are built up out of the marl itself.

This is all very well; but so long as one had but the diaphragm pump, the problem of how to get the marl in available form was by no means solved. It remained for a local mechanic to perfect a method of agitating the thick marl, thus getting it in shape to deliver to the pipe leading to the pump. The device, which both bores the marl and elevates it, is mounted on a raft and the huge auger is turned by a gas engine also mounted to the raft. It consists of an auger with adjustable blades in a twelve-inch housing. The blades extend about an inch lower than the housing and cut a marl cylinder fourteen inches in diameter. This makes a hole a little larger than the housing which permits the water to enter which, together with the loosened marl, is sucked up into the housing. In the top of the housing are two 2-inch ports through which the marl-charged water is delivered to the intake on the pump. The hose permits wide latitude in boring the marl, and it will be seen that the problem of getting out a large tonnage of marl is solved. The auger can be lowered twelve feet into the marl bed, so the outfit seen in the picture can remove several hundred cubic yards of marl before it must be moved. The winch operated by hand regulates the rapidity of boring and is regulated to loosen just about as much marl as the pump can take care of. The tests show that the arrangement is capable of delivering a cubic yard to the bank every four minutes. This is more than ample to put the recovery of the marl upon a satisfactory commercial basis.

With the vanes in motion in every passing breeze, no passer-by can overlook this novel advertising sign

An Advertising Wrinkle

UNIQUE among advertising media is the windmill sign invented by Hugh Correll of Canton, Ohio, and caught by our photographer in the act of proclaiming the merits of one of Canton's retail stores. The sign is mounted on a structural steel standard, and revolves on standard taper bearings. Both sides of all four wings are used for display. The weight of the wings is exactly balanced, so that the slightest breeze sets them in motion.

Our Strenuous Geological Survey—III

How Geologists and Water Engineers Keep Track of Our Natural Resources

By Guy Elliot Mitchell
United States Geological Survey

THE geologists of the United States Geological Survey are all outdoor men, for this is a distinctly field service, though their reports require much office study and correlation. Each geologist brings to bear on his own observations and problems all the related experience and research work of other geologists. The geologist as a rule follows the topographer; he may do good geologic work independently, but his work is greatly facilitated if he has the basic topographic map. He observes and then locates exactly on this map the distribution of the various kinds of rocks. The work of the United States geologist is widespread and extends into every State in the Union and into Alaska, Hawaii and our West Indian islands, and as a result geologic maps representing thousands of square miles are published each year. This work is done by about 90 geologists.

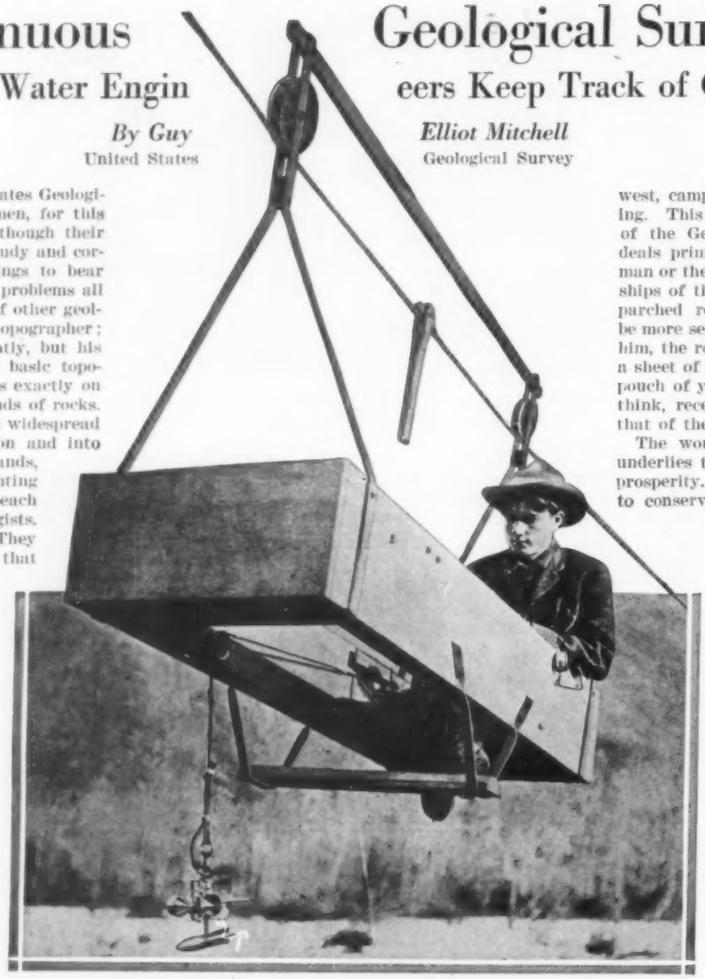
Of what use are these geologic maps? They are applied to many uses. Maps of areas that include pools of oil and gas show the lay of the rocks deep below the surface and the places at which further drilling is most likely to result in producing wells. Maps of coal lands show what areas are underlain by coal, and many of them indicate the depth of the coal below the surface. Such a map is accompanied by a report which, if it covers a coal field, gives the data for determining the tonnage of coal within any part of the area covered. Some of these maps show not only where water-bearing formations outcrop, but how deep they lie below the surface and how far a man must drill to get water. Maps of many mining districts show the localities most favorable for prospecting for ore deposits.

Where the geologist leaves off, the mining engineer takes hold, and in examining and appraising a mineral property the mining engineer's first inquiry is for the map and report of the geologist. The same may be said of the constructing engineer, whose first inquiry usually is for the map showing the rock structure or the character of the foundation upon which he must build.

The Geological Survey has thus mapped and reported on hundreds of thousands of square miles of the United States, showing the location of coal beds, phosphate beds, iron ores, gold-bearing rocks and placers, silver, copper, lead, and zinc bearing rocks, limestone, marble, granite, slate—in fact, every kind of precious and useful mineral, from rare minerals, such as radium ores and gem-bearing formations, to common brick-clay deposits. It has been possible to estimate the reserve supply of some of the minerals in the ground, both that of local deposits and the total for the country as a whole. Our total known coal reserve, for instance, is estimated at 3500 billion tons, or more than 7000 times as much as was mined last year, and our known high-grade iron-ore reserve is estimated at 7½ billion tons, or about 250 times as much as was mined in 1921.

While the topographic engineer works solely on the surface the geologist must look down a thousand, or two thousand, or three thousand feet into the ground. He is a good deal of a magician, being able to see with definiteness that a certain tract of 1255 square miles of land in Utah, we will say, is underlain at a depth of from 1720 to 1970 feet with a 9-foot bed of bituminous coal, and that under this same area, further down, at a depth of 2900 feet, there is another coal bed 31 feet thick; or to locate definitely and estimate the tonnage of phosphate and other minerals. So he becomes the national appraiser of our many mineral resources.

Of our great 105,000,000 population there are comparatively a chosen few who have ever heard of the United States Geological Survey, or have any conception of the value of its geologic work. Indeed, when it was suggested some years ago by a certain member of one of the Houses of Congress that the Geological Survey had never made a discovery, never undertaken an exploration and never located a mine, his statement received the approving nods of many people, including some editors. In a vague sort of way the supposition seemed current that there were two classes of "geologists," the closet scientists and the summer geologists. The one class included the "professors" who spent their days in poring over books containing 13-syllable words and in hammering and scrutinizing small specimens of rocks sent them from different parts of the country; and the other class included a lot of boys, old as well as young, who went off every spring and summer on surveying jaunts into the west, camping out in the mountains, hunting and fishing. This mistaken idea was perhaps natural; the work of the Geological Survey is little known because it deals primarily with natural phenomena and not with man or the works of man. Although the trials and hardships of the geologist in the wilds of Alaska or in the parched regions of the Great American Desert may be more severe than those of the gold miner who follows him, the result of the geologist's trip is told in lines on a sheet of paper, while the miner may display a bulging pouch of yellow dust or nuggets. Which story, do you think, receives the most notice in the morning paper, that of the issuance of a map or of a gold strike?

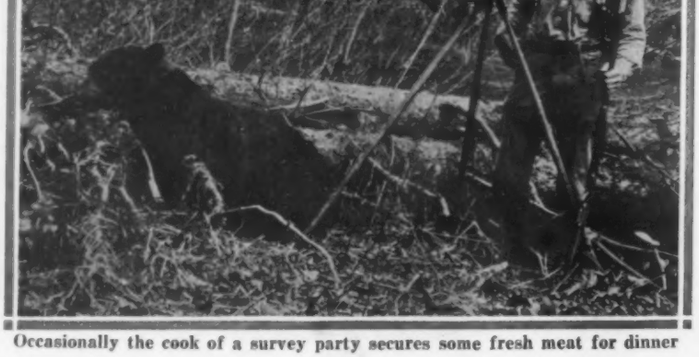


A typical cable car for measuring the flow of streams

The work of the United States Geological Survey underlies the very root and foundation of our national prosperity. Upon its investigation must rest all efforts to conserve, maintain and properly utilize our great natural resources. The gold miner may pick up the gold where he finds it, but unless he brings the results of mining geology to bear upon his work, he does it in a haphazard way, often wasting in barren ground what he had gained in the richer area. The coal operator may mine vast quantities of coal, sending train-loads of it to all points of the compass, but he may at the same time be wasting one half as much as he markets, regardless of the fact that the nation's supply of cheap, easily mined, coal may not last more than a couple of hundred years. Swamps may be drained; but without consideration of the increased channel capacity required, the accelerated flow may ruin more land along the lower reaches of a river than is benefited higher up by the drainage itself. In all these and many more physical problems the investigations of the Geological Survey are fundamental; they comprise a basal study of every physical characteristic of the country and upon these studies rest the integrity of every great engineering work whereby natural resources are turned to man's advantage. But where the Survey leaves off, there the constructive work of the various institutions, public and private, begins; and it is of this that the public hears, not the foundation work upon which the construction is based.

I shall mention just one specific item, as an example; many more could be cited. One of the big features in farming of the near future, and indeed of today, is an adequate supply of mineral phosphate for use on American farm soils. The prosperity of the country depends on the crops produced on our farms, and their crop-producing power depends more and more on the replenishment of the soil with phosphates, one of the three plant foods absolutely necessary to plant growth. The supply of rock phosphate in the United States for many years was derived from South Carolina, Florida, and Tennessee but at the present rate of increase in consumption the high-grade rock phosphate in these eastern fields will be exhausted in less than a generation. During the last few years, the Geological Survey has discovered, analyzed, and mapped deposits containing billions of tons of high-grade rock phosphate, mostly on public lands, in Utah, Idaho, Wyoming and Montana, and has thus assured a continuous supply for centuries to come.

This was a genuine discovery. Phosphate rock, it was known in a vague way, existed in Wyoming. It was a sort of curiosity; but Survey geologists traced the beds for miles, mapped them, found new deposits hundreds of miles distant from the original outcrop and gave us, instead of a statement that there was "phosphate in Wyoming," a concrete accounting of two and a half million acres of phosphate land containing 5,800,000,000 tons of high grade phosphate rock. On this finding over two million acres have been created into "phosphate reserves" to remain the property of the people of the United States free from possible monopoly and subject to develop-



Occasionally the cook of a survey party secures some fresh meat for dinner

ment by leasing from Uncle Sam. Who can measure the value of this work?

That the United States Geological Survey is a good training school for adventurous undertakings is well evidenced by the list of ex-Survey geologists and engineers or those on extended furlough who are traveling and investigating in all four quarters of the globe; in India, in China, in Africa, and in South America by the score these men are invading the largely untrodden wildernesses looking for gold, for oil, for platinum, and for other mineral resources.

There is another class of Geological Survey field man who has his adventures, somewhat mild ones perhaps, but he gets more enthusiastic than some of the others—the paleontologist or paleobotanist, who becomes scientifically excited over the discovery for example of a fossil clam or leaf which lived at the close of the Paleozoic age, which is computed to be some millions of years ago. Now and then he may find the petrified remains of a giant dinosaur or a titanothere and thus get a paragraph notice in the newspapers but of far more importance is the discovery of some common looking mollusc of great prehistoric age, or a fossil leaf of a species which is always found in a rock stratum of a certain age, the formation produced just before or just after the time when certain coal deposits were laid down, for instance. This little fossil is therefore a sure indication to the geologist in his search for such coal bearing strata. Such work, then, finds practical application in determining the ages of the deposits in which the fossils were found, for the deposits of particular ages or times contain certain characteristic fossils or groups of fossils. Paleontology, as Major Powell, former Director of the Survey once explained, is the geologist's clock, his means of finding the time in the geologic history of the world when any particular fossil-bearing bed was laid down and, therefore, its relations to other beds.

Wading measurements of river volume

All this work has its practical side, its economic value to the public. To the layman it might seem a waste of time for a man to spend an hour in peering through a microscope at a piece of rock a thousandth of an inch thick cut from a specimen he collected in the field, but that bit of rock may disclose the secrets of an ore deposit. In such a rock section the geologist may find the solution of problems of the greatest importance to the mining and quarrying industry, so that even this study in seemingly "pure science" has its dollars-and-cents value.

If a geologist needs to know the minute details of a specimen of granite, he has a chip of the rock sawed off and then ground down until he can see through it; then when cemented between glass plates it is ready for his study. A piece of granite as seen through the microscope may then show the quartz, feldspar, mica, and hornblende that make up the rock, and the minute grains of copper sulfide from which the ores in a neighboring vein were derived. In the same way a specimen of chromium-bearing sandstone seen through the microscope reveals its internal structure—rounded and angular grains of quartz cemented together with chalcedony, in which there are curled flakes of mica. Another microscopic examination of stratum above an "oil sand" may show minute fossils, indistinguishable to the naked eye, which disclose oil secrets to the up-to-date driller.

Quite comparable with the geologists, and most appropriately mentioned in the same breath with them, are the hydraulic engineers of the Geological Survey, among the most active of any members of Uncle Sam's great field force of scientific investigators. Winter and summer, rain and shine, during chinook and blizzard they work, as an admiring but ungrammatical young enthusiast once said, "irregardless of the weather." They are the men who measure the volume of the flow of the rivers of the United States. Now if you are trying to learn all the eccentricities as well as the "normalcy" of a river you must measure its flow every day in the year, because one month it may be a raging torrent 40 feet deep and the next month you may be able to wade across it. Therefore, we will take a flying trip around some of the western river-measuring stations of the Geological Survey and see what these water engineers are up to.

Caching provisions against the return trip

In Colorado the weather is fairly warm although it is getting late in the season; and to measure the Grand River, one of the great arms of the Colorado of the West, the engineer runs his flivver down to the place selected as a "station" and slipping on his hip-rubber boots—which come up to his armpits—wades in with his electric current meter in hand and at five-foot intervals records the velocity of the current. Previously he has made an accurate survey of the river bottom at this point—a profile—so that when he gets back to the branch office of the Survey in Denver he can readily compute the number of cubic feet of water per second which was flowing down this river at the time of the measurement. If the next day the river has risen or fallen half an inch, the totals will be entirely different.

Measuring river-flow in winter

Next we will jump over to the Hetch Hetchy Canyon in California. Here the water is too deep and the current entirely too swift for wading so the engineer has had to set up a stout tripod on either bank or perhaps has utilized a tree and has strung a wire cable across on which runs a car. Into this he climbs, pulling himself across the river and making measurements at regular intervals. On some of the big rivers, the Susquehanna for instance, these cables are a thousand feet long but such an expensive outfit is warranted because a thorough knowledge of the flow of rivers is of the utmost importance to the country at large and especially to certain captains of industry who may be figuring on installing a five-million-dollar water-power plant. Of course some rivers located in the effete, settled districts of the country can be measured from bridges.

"But how about rivers that are frozen over tight during the long winter months?" you ask. Let us run up on to the Wisconsin River during January. The engineer is ahead of us, and he is having a little diversion mixed in with work—he is fishing through holes in the ice. Well, this is probably all right. A little sport mixed in with official work may be proper. It carries out the old idea that the Geological Survey is a nice service to work in. But where are the fish? As it happens the engineer is working much harder than a fisherman. He is simply using the ice as a winter bridge and he has cut holes at regular five or ten-foot intervals, into which, one after another, he drops his electric current-meter which gives him the flow of the river every day in winter. There are over 1200 of the river measuring stations all over the United States today, and to maintain some of them through the winter is not child's play.

In the arid West the stream-gaging work of the Survey has been made the basis for the irrigation work of the Reclamation Service, formerly a branch of the Geological Survey. Indeed, it may be added that much of the engineering work of the Reclamation Service rests solidly upon the preliminary topographic explorations of the Geological Survey. The determination of the water supply available for irrigation has been made by the Geological Survey. The utilization of the waterpowers now in public ownership is a coming chapter in the nation's industrial development and here again the field work of the Geological Survey gives Uncle Sam his necessary basic information. Water is unquestionably our paramount mineral resource. All great industries, agriculture, manufacture, transportation, and mining depend on it, and it is fortunate, indeed, that the Nation is beginning to recognize the supreme value of its water resources.

The underground water geologist is a type of field wizard. In fact, he's actually "queer." N. H. Darton is such a one. A hundred years ago he could have been convicted a dozen times for practicing black magic. He appears to be able to look down into the ground a couple of thousand feet and confidently tell you whether there is water there or not, and he does not use a witch-hazel divining wand, either.

"Here is a little story for you," Darton said one day, strolling into my room. "The Chicago, Milwaukee and St. Paul Railroad wrote in to the office a short time ago asking me to come to Edgemont, South Dakota, prospect the country around for a month or two and advise them as to the underground water prospects. They said they were badly in need of a good water supply. Of course I could not undertake any private work, but I got out some of our maps and after studying them a bit wrote the company that the drill would strike a heavy flow of artesian water at 3000 feet. This was so casual and off hand that the directors of the company seem to have balked, but they finally decided to drill and I have just had a telegram congratulating me on the fact that they have struck a half-million-gallon-a-day flow in this semi-desert region at a depth of 2981 feet,"—a fairly good guess!

A few years ago Congress made an appropriation to the Geological Survey for discovering, developing, protecting, and rendering more accessible, springs, streams, and water holes on the public lands of the United States, and for erecting desert monuments and signboards. This work has afforded much valuable data on the driest, hottest, and least explored part of the desert region of the Southwest, an area of strategic importance because of its inclusion of part of the Mexican boundary, so that this work was also actually a war prevention measure. To date about 60,000 square miles of dangerous desert has been signposted, greatly reducing the dangers of desert travel. These data and all other reports of the Geological Survey relating to surface and underground water are furnished to libraries and sent free to the public until the editions are exhausted.

Geologist measuring a Colorado coal vein

This is the third article of a series on the work of the Geological Survey. The next and final instalment will appear in the November issue.
—THE EDITOR.

Sewer Pipe Investigation

A VERY important investigation which is being conducted by the Bureau of Standards deals with the deterioration of sewer pipe under severe conditions. In cooperation with the city of Los Angeles and the manufacturers of clay and cement pipes, the Government's experts are planning an elaborate investigation covering actual service conditions in the above-mentioned city.

The program for the investigation involves the excavation and inspection of sections of pipe throughout the city and the replacement of some of these with tested pipe for future examination. The major part of the work, however, consists in the installation of small sections of pipe in manholes in such a manner that a part of the specimens will be submerged in the sewerage and a part exposed only to the action of the sewer gases. The points at which exposure has been made have been selected in such manner as to cover typical conditions throughout the system and at these points periodic analyses of the sewage and gases will be made to determine the concentration of ingredients which may be injurious to the pipes.

It is hoped that as a result of this investigation general relations will be established between the rate or extent of deterioration of pipes and the concentration of damaging elements in the sewage and gases. The problem is a difficult one, not only on account of the extent of the work involved, but more particularly because practically no work has been done along these lines heretofore.

The Golden Age of Peru

Speculations as to Its Magnitude, and Relics from It Recently Added to Our Museums

THE tale of Peruvian gold will never die. It is in the same class with the stories of lost mines in our own west, and people will always believe it, because they want to. Whether the Incas were possessed of such vast stores of the yellow metal as are credited to them; whether a captive Inca was ransomed from the Spanish conquerors by the payment of tons of gold; whether a ransom of this magnitude was really concealed in the hills when its carriers learned that their ruler had been put to death regardless, and still awaits the lucky searcher — these tales may or may not be true.

Water vessels with combination spout and handle are common from the north coast of Peru, but made of clay rather than gold

We do know, however, that the natives of Peru were familiar with gold. It was to them a metal easily worked, imperishable, easily adapted to works of utility and of art. It does not appear to have been employed as currency or in barter, but was rather set aside for the use of artist and artisan in palace and temple. The conquering Spaniard was doubtless dumbfounded to find it in such common usage; and in turn the Peruvian must have been no less astonished to learn what store the white invader from beyond the sea set by the yellow metal.

In "Natural History," the excellent publication of the American Museum of Natural History in New York, two articles have recently been published on "The Golden Age of Peru" and "Peruvian Gold of the Chimu kingdom." The first of these articles, by Mr. Hamilton Bell, takes up the historical account of gold in Peru and clarifies some of the extravagant stories. Mr. Bell traces to its source and rather indorses the tale of the slaughtered Inca, and places at $17,000,000 the sum of his ransom.

Quoting old authorities, Mr. Bell tells us that the royal palaces, which were scattered over the vast empire, were walled and adorned with the precious metals within and without. They did not have tapestries for the walls, for they were covered with gold and silver. Connected with the palaces were golden gardens like those in the temples of the Sun. All the vessels, large and small, for the whole service of the palace, including the kitchen, were of gold and silver. The baths, with the pipes for bringing the water, were of the same precious metals. The Inca usually sat on a stool of solid gold, a *tercia* in height, which was placed on a great square board of gold.

These things were in each royal lodging so that the Inca might not be under the necessity of carrying them about with him. When he died, his palace was left in statu quo, sacred to his memory. All his personal vases, jars, basins, kitchen service of gold and silver, and all his clothes and jewels were buried with him, and his successor began an accumulation anew. There may be some exaggerations in these accounts, concludes the author, but that gold was freely used for the decoration of temples, for the overlaying of the thrones of the Incas, and for the household utensils of their palaces he thinks can hardly be doubted. He tells at length the story of the golden chain which one Inca was alleged to have had made at the birth of his son, and how on the coming of the Spaniards this and much other treasure was supposed to have been thrown into the lake of Urcos. This lake the invaders attempted without success to drain in 1557. As to the chain itself, Mr. Bell points out that unless we are to understand that it was merely gilded or plated, the amount of metal required for its construction hardly allows the story to be accepted. These early stories of hidden gold and the many still current in Peru must be considered largely as legendary. The fact that the golden treasures were concentrated in the palaces and temples made it easy for the Spaniards to gather them up and we may be sure they did not cease their efforts until they were no longer repaid by success. North of Peru, in Ecuador, Colombia, and Costa Rica, objects of gold were commonly buried with the dead and it is still possible to recover them. The location of graves and the digging of the treasure is a regular occupation in many localities. A small percentage of the graves of Peru still yield gold ornaments but not in commercially paying quantities. But this does not discourage either the dreams or the attempts to secure sudden wealth by finding the great Inca treasures.

The second article referred to is by Pliny E. Goddard, Curator of Ethnology in the Museum, and describes specific articles found among the remains of the ancient Chimu kingdom of Peru. It has to do especially with a collection of twelve gold objects recently secured by the museum. Among those already familiar were three plume-shaped pieces evidently intended for wearing in a headband. The museum already had such specimens, ranging from four to eight inches in length; but one of the new ones is 17½ inches long and 5⅞ inches wide, the other two being also larger than those previously in hand. Breastplates and water-jars comprise the balance of the collection.

The material of which these objects are composed is an alloy of gold, silver, and copper, varying somewhat in proportions but averaging about 60 per cent gold, 20 to 30 per cent silver, and 6 to 20 per cent copper. One of the breastplates with alternating bands of light and dark metal gave interesting results upon analysis. The yellower metal was 80 per cent gold, 13 per cent silver, and 7 per cent copper, while the lighter bands were 47 per cent gold, 44 per cent silver, and 8½ per cent copper. Such alloys are fairly hard and cannot be beaten with the same ease as purer gold.

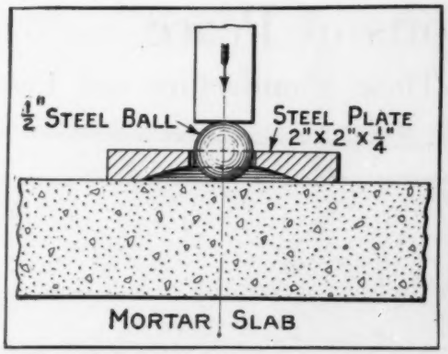
Portrait of an Incan chief

It appears that these objects were first cast in prepared mold and then finished by hammering, and perhaps retouched with an engraving tool. Only by bringing the material to, or close to, the melting point could a union be obtained between the strips of light and dark metal in the two breastplates. The combined handles and spout of the two water vessels were made into a tube by approximating the two edges and applying heat and probably also by the use of a lower alloy to act as a solder.

The method, that of casting instead of hammering, the fish design, the shape of the water vessels, and the alloy all indicate that the several objects were made on the northern coast of Peru. It is not surprising that the people in this particular region had made considerable progress in working with metals. Gold seems to have been generally common in the sands of the coastwise streams. Its sparkle undoubtedly attracted the eye of the people and, when it was found to be easily malleable, its use in the arts was appreciated. It may be that copper was also first found in its pure state. By the time the Spaniards entered the region, however, considerable progress had been made in taking silver and copper ore out of the rock of the mountains and reducing the metals by means of blast furnaces. Two methods seem to have been employed in smelting; one was the use of a small pottery blast vessel, around which a number of men gathered with long copper tubes and blew the fire until the required heat was secured. A second method, spoken of in the early accounts, employed blast furnaces, which were located on the mountainsides where the strong prevailing winds furnished the necessary blast. All of which goes to prove once more that the Incas were an ingenious race.

Cannon-Ball Tests of Concrete

AT the Purdue University Engineering College a new and satisfactory system of testing concrete and mortar by the novel use of miniature cannon balls has been devised recently. A steel ball one-half inch in diameter, with a steel plate two inches square and one-quarter inch thick pierced by a hole one-half inch in diameter through its center, comprise the simple apparatus used. The plate is arranged above a specimen of concrete or mortar to be tested with the steel ball placed in the hole of the plate so that a load may be applied to the ball through the moving head of a testing machine or by use of a special jack. Enough force is then exerted to drive the ball a distance of one-half inch into the concrete.



The technique of ball-testing of concrete, and a test slab showing the depressions made by the balls

Experts of the Committee on Highway Research of the National Research Council speak in this way concerning these unusual Indiana experiments: "The test is being used in the Purdue Laboratories to study the effect of wheel loads on the surface of the mortar slabs. A 34-inch truck wheel with a 4-inch solid tire is pressed on the slab with a load of 1000 pounds. The load is then increased and the wheel again moved to a different place on the slab. In a similar manner several increments are added to the load and each time the wheel is moved to a different part of the surface. The ball test is applied to the parts of the surface subjected to each load and the effect of the increase is indicated by the loads required to force the ball into the surface. The test has been applied thus far to slabs 7 and 28 days old with satisfactory results. In each case the load required to force the ball into the slab decreases with an increase of the load applied by the wheel. The load necessary to force the ball into the concrete indicates the strength of the surface of the concrete mortar."

This test and the apparatus involved are so simple that many practical applications of the novel investigations may be made. For example, it can be employed to ascertain when concrete used in building roads or other structures such as culverts and bridges has cured sufficiently so that it is hard enough to support traffic or to permit of the removal of the forms. In the case of concrete highways, the test could be applied successfully by using a hydraulic jack above the steel ball. The weight of a motor truck could be applied to the jack to sink the ball into the concrete the proper distance.

It is also probable that these tests may throw much light on the perplexing problems associated with concrete fatigue. Road investigations in California show that samples of concrete taken from roads that had been under service for long periods were much weaker in compressibility than similar cores abstracted from highways of more recent construction. Maryland engineers have also attempted some elementary testing work designed to determine some of the causes of concrete collapse due to fatigue. The Illinois State Highway Commission is also running fatigue tests along somewhat similar lines. Results obtained at Purdue indicate that concrete will rupture under a repeated load that is considerably less than the once-applied load required to break it.

The Age of Insects

THIS has been called the age of man. Is it not really the age of insects? They occur almost everywhere. They actually imperil our existence by attacking crops, destroying forests, annoying and worrying domestic animals, and are well-known carriers of deadly infections, such as typhoid fever, yellow fever, cholera and sleeping sickness. Were it not for the beneficent activities of birds and many other natural agents, we would be overwhelmed by the numerous pests contemptuously designated as bugs. There are in New York State some 20,000 different species of insects and perhaps 100 entomologists engaged in collecting and studying them. There are, presumably, more than 100,000 species in the United States with over 1000 entomologists, and in the entire world a million to ten million different species of insects (a large proportion unknown) and a relatively much smaller group engaged in their study. Each of these insects occurs in four distinct stages, namely, the egg, the maggot or caterpillar, the pupa or chrysalis and the adult or perfect insect, consequently the entomologists of the world are engaged in the stupendous task of classifying and learning the habits of four to forty million different forms. Accurate differentiation must precede investigation of life histories, otherwise deplorable confusion is almost inevitable. There is no group in the animal, the vegetable or the inorganic kingdom which presents so many diversities as the exceedingly numerous and varied forms known as insects. It usually takes several years, and frequently much longer, to work out a satisfactory life story of even one insect, consequently a limitless field is before us.—Abstract from address by E. P. Felt before the Entomological Club of Madison, Wisconsin, *Science*, May 19, 1922.

The Prevention of Decay in Stonework

THE *Journal of the Royal Society of Arts* (British) for December, 1921, contains an account by Mr. Noel Heaton of the various attempts which have been made to solve the important problem of preventing the decay and disintegration of stonework in buildings. The causes of disintegration may be natural, such as fluctuations of temperature, rain, erosion by wind, and, in ferruginous sandstones, oxidation. The growth of vegetation on stone usually hastens decay. The most potent cause of decay is, however, the "unnatural" action of sulfuric acid, derived from coal smoke, coupled with the accumulation of soot and grime. It is estimated that, e.g., 80,000 tons of sulfuric acid are thrown annually into the London atmosphere.

An indirect method of preventing decay is to further, by every possible means, the campaign against atmospheric pollution. The stone may be treated with preservatives, which were divided into three groups: (a) those acting merely as surface coatings; (b) those impregnating the stone without chemical action; and (c) those operating by chemical reaction with the stone. In the first class are paint and limewash, the latter being useful where the stone is subjected to a moist atmosphere, but protected from rain. In the second class are mineral wax applied by heat or in solution in benzene, drying oils, creosote or gelatinous precipitates formed on the stone. In the third class treatment with baryta is effective in repairing a stone disintegrated by sulfuric acid. A common method is the deposition of silica or silicates. Treatment with waterglass leads to unsightly efflorescence. This may be reduced by treating with a solution of arsenic acid after the waterglass, but the most satisfactory results are obtained with silicofluorides, introduced in France by Kessler in 1883. Too strong a solution should not be used (not stronger than 10 per cent), and the mode of application should be adjusted to particular conditions.

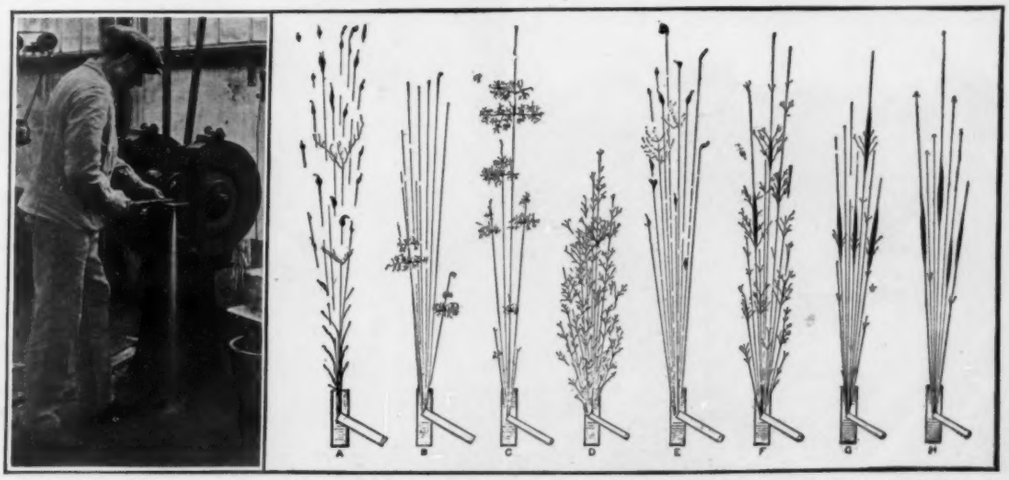
Testing Steel by Striking Sparks

NO small part of the time consumed and the expense incurred in the manufacture of steel and in the fabrication of steel parts goes to meet the necessities of testing. At all stages in the production of steel from iron the most careful chemical control is necessary; and wherever ingots and bars are used as the raw materials of manufacture, elaborate physical tests must be made to insure that the tensile and compressive properties of the metal are up to the mark.

With modern methods of analyzing the steel by means of the electrical and magnetic properties, which we now know to vary with the physical condition and the chemical composition of the metal, this is not as serious as it was when straight mechanical tests were the only ones available. Nevertheless, there is ample room for the shortening and simplification of metallurgical tests; and a long step in this direction has been made in France within the past few years.

All steels, of course, give off sparks when brought in contact with a rotating grindstone. The discovery is now made that the character of the spark varies with the carbon content and with other properties which largely determine the physical characteristics of the metal. The correspondence is not as exact as a careful scientist would require for laboratory work; but for a rapid and practical analysis in the shop the method has been developed to a point where it meets all needs.

Without going too deeply into details, it may be pointed out that the sparks struck off from a steel by a grindstone may be thin or fat; they may explode or may die down without disruption; they may form a narrow or a broad sheaf of rays; and they may vary in color through quite a range of reds, yellows and whites. It will, of course, be realized that temperature and hardness are the factors primarily involved; that temperature itself depends largely upon the hardness and toughness of the steel; and that the size of the sparking fragment of metal has much to do with the precise appearance to be observed. By a careful series of observations a series of standards pertaining to the various degrees of carbon content, tungsten alloying, etc., has been worked out, giving a sufficient basis of comparison. The claim is made that, with very little practice, any ordinarily intelligent man without technical experience can make a wide variety of tests which have heretofore required very special knowledge and skill.



A: Magnetic steel (orange). B: Quick steel (dull red). C: Manganese steel (white). D: High-carbon steel (white). E: Quick steel of another sort (very clear red). F, G, H: Hard, semi-hard and soft steels (white or pale yellow)

Spark testing of steel, and some characteristic sparks shown diagrammatically

The Thunderbolts of Peace

Modern Industrial Explosives—Their Manufacture and Use

By Arthur La Motte

TO the average citizen, the word "explosives" is associated with battles and bursting shells, with bomb outrages and burglars. To the quarry or mine operator, explosives represent a means by which he can meet his pay-roll and perhaps pay dividends. To the engineer, they are the second most important item in the construction of canals, the building of railroads, the deepening of harbors, and the production of metals and minerals.

Mixing house at a powder factory, showing the barriers erected to localize any explosion that may occur

The steel industry is by common consent looked upon as the index of business in this country because next to farming it is our greatest single industry; and the whole steel industry is dependent upon explosives for the production of its finished product. In the enormous pit mines of the Mesaba Range in northern Minnesota, explosives are used to break down and loosen up the iron ore so that it can be handled by the steam shovels. In the bituminous mines of western Pennsylvania, explosives are used for breaking down the coal which is later made into coke for the reduction of this iron ore. In the big quarries of the lower Michigan peninsula, explosives are used in immense quantities for blasting out the solid limestone, which is subsequently crushed and shipped to the furnaces where it is used for a flux with the coke and the ore for the manufacture of iron and steel. Not only are railroad trains and tracks, ships and engines, bridges and highways, buildings and automobiles constructed from the metals or the stone produced by the aid of explosives, but also very many familiar articles of every-day life are dependent at some stage on explosives for their economical production.

To the man in the street again, explosives are simply explosives; but in the minds of manufacturers and users they are classified in two general groups: military and sporting powders, which are mostly propellants with some disruptives like T. N. T. for shell-bursting charges, mines and bombs; and commercial explosives, which are all disruptives. Modern commercial explosives consist of active-base straight dynamites, gelatin dynamites, ammonia dynamites, nitrostarch powders, the so-called permissible explosives and a very recently developed dynamite called by the trade name dumorite.

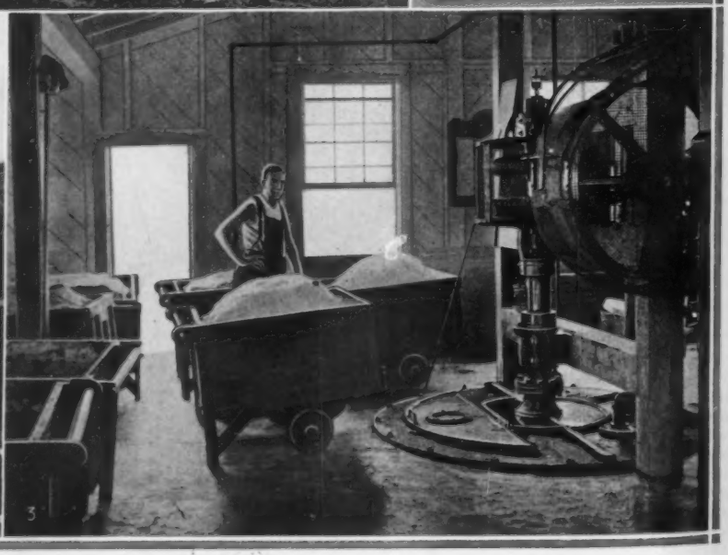
The active-base straight dynamites are direct descendants of Nobel's original dynamite, the inert kieselguhr with which he mixed his nitroglycerin having been displaced by a mixture of wood pulp and nitrate of soda, while the nitroglycerin remains as the chief explosive ingredient. Gelatin dynamites are similar to the straight dynamites except that in addition to the other ingredients they contain nitrocotton dissolved in the nitroglycerin. This forms a mucilaginous or gelatinous mass and makes a plastic and highly water-resistant explosive. The ammonia dynamites are similar to the straight dynamites except that part of the nitroglycerin is replaced by nitrate of ammonia.

Both the straight and the ammonia dynamites are now low-freezing. By a process known as polymerization, it is possible to treat glycerin in such a way that when nitrated it has a much lower freezing point than pure nitroglycerin. Prior to this development men were frequently killed by toasting dynamite in front of fires, over boilers and even in their hat lamps.

The nitrostarch powders contain no nitroglycerin. All their ingredients are solid and they are, therefore, unaffected by low temperature and are called non-freezing. They have been fairly successful in open work such as quarry blasting and construction work, but are not much used in mining, as they lack the high density of gelatin dynamites and the fumes seem to be objectionable.

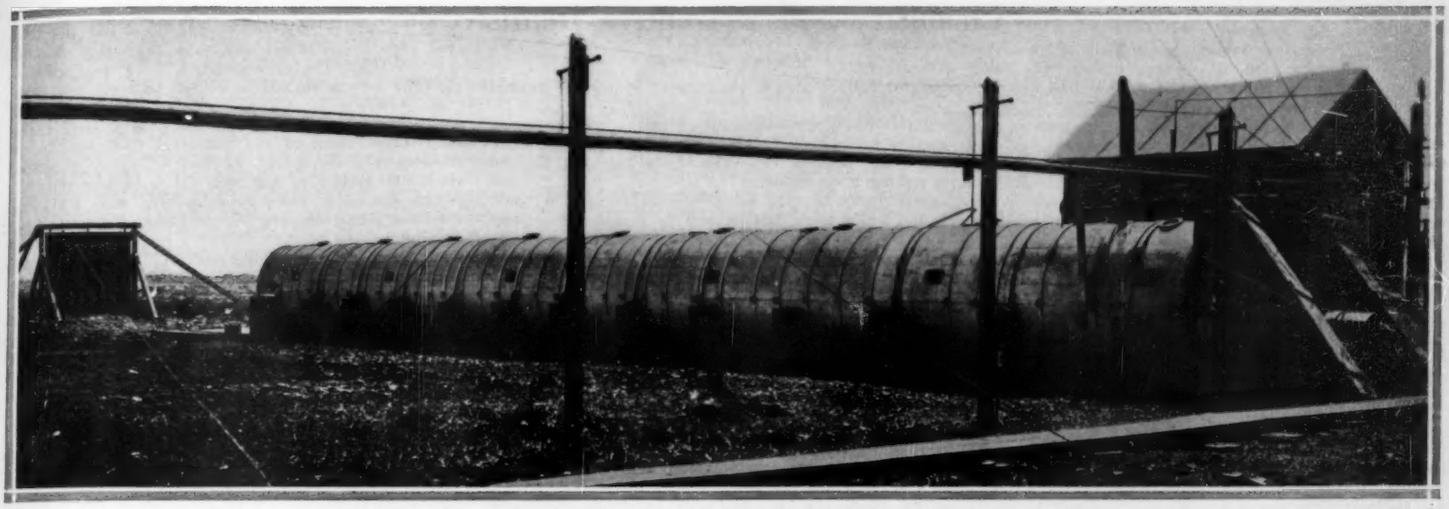
The permissible explosives may be of either the ammonia type or the straight dynamite type. Their distinguishing characteristic is the short duration and low temperature of the flame they create, and they take their name from the fact that they have been approved by the Bureau of Mines as permissible for gaseous and dusty coal mines, where their use has greatly decreased the danger of accidental explosions.

The recently developed dyna-



1: Exterior view of one of the units. 2: Powder trucks on the plant railway. 3: Inside the mixing room

Where T.N.T., the most famous but far from the most powerful explosive, is made



Gallery used in testing the safety of explosives for use in dusty and gaseous coal mines

mites of the dumorite type consist of nitroglycerin and guncotton colloided together in a hornlike mass, then ground up into powder and mixed with nitrate of soda or nitrate of ammonia. The resultant explosive has the chemical advantages of nitroglycerin and nitrocotton without their physical drawbacks—one of which is the propensity of the nitroglycerin to produce headache—and the further advantage of the very low charging density of the nitrocotton.

No story on high explosives would be quite complete without some mention of T. N. T., or trinitrotoluene, which is by far the best advertised explosive in the world, but which is not anything like so terrible as it sounds. It is a yellowish-brown powder with a rather low melting point, looking not unlike ground mustard. It is about as strong as the medium strengths of dynamite, say 40 or 50 per cent, but not anywhere nearly so strong as the 60 per cent dynamite or blasting gelatin. It has the advantage of being insensitive to shock and it requires a very powerful detonator to start the reaction. Most of the accidents with T. N. T. have been due to its being heated to a dangerously high point, or to its detonator's being fired by external means. Large quantities of T. N. T. from surplus government stock are now being used by farmers for stump blasting and ditching, but when this stock is exhausted, T. N. T. will probably not be used commercially, as its cost of manufacture is high.

Black powder, which is merely a physical mixture, is made pretty much as it was one hundred or five hundred years ago. Saltpetre (potassium nitrate) or Chile saltpetre (sodium nitrate) is ground up in a wheel mill and incorporated with sulfur and charcoal under heavy iron wheels. This mixture is then pressed into hard cakes which are next broken up into grains and these are sorted out into different sizes and glazed. The finished powder is then packed in iron kegs of 25 pounds each. Black powder made from potassium nitrate is used particularly for the manufacture of fuse, fireworks and sporting powder, whereas the black powder manufactured from sodium nitrate is used for blasting, by far the greatest proportion being used for blasting coal.

Smokeless powder is produced by the most intricate and delicate manufacturing operations in the explosive industry. In blasting operations, if the explosive shows a variation of a few thousand pounds pressure one way or the other, no particular harm is done, but smokeless powder for propelling projectiles in guns must develop exactly the same pressure within extremely close limits day after day and year after year. Higher pressures than those allowed will burst the guns and lower pressures will cause the projectile to fall short.

For the manufacture of smokeless powder, raw cotton is first purified and dried and then nitrated by being dipped in a mixture of nitric and sulfuric acids. The nitrated cotton is next washed and purified by boiling and pulping and the wet nitrocotton is then dehydrated by replacing the water with alcohol. After this more alcohol and some ether are added and the mass is mixed until it becomes a homogeneous and amorphous dough. This dough is then forced through dies somewhat similar to a macaroni machine, by which, in the case of cannon powder, seven axial perforations are made in the cord. The cord is then cut off into short lengths two or three times its diameter. These are finally dried to expel the excess solvent, a process which may take from several days to several months, after which the powder is ready to be used.

The manufacture of commercial high explosives, like that of smokeless powder, is a delicate operation which requires close chemical control to secure a uniform product and to insure safety of operation. It starts with the manufacture of the nitric acid and sulfuric acid, which are then mixed together in the correct proportion and strength, cooled and run into a large cylindrical tank containing brine cooling-coils, after which the glycerin of highest possible strength is slowly run in with constant and vigorous agitation. The temperature of this reaction is controlled by the brine coils and by running in the glycerin slower or faster. After the nitration is completed, the emulsion is run off to a settling tank where separation occurs, and the nitroglycerin is drawn off from the top and thoroughly washed and purified. The next step is the mixing in specially constructed wood and rubber tubs of the nitroglycerin with the nitrate of soda, wood pulp, and nitrate of ammonia if it is to be an ammonia powder; until the nitroglycerin is thoroughly incorporated with and absorbed by the other ingredients. The powder is then taken to another machine constructed of wood and rubber where it is packed into cartridges of paraffined manila paper, after which it is boxed ready for shipment.

If gelatin dynamite is desired, the nitroglycerin is run into a steam-jacketed bowl and the necessary amount of nitrocotton of the exact character calculated to give best results is added and dissolved in the nitroglycerin, making a sticky, mucilaginous mass. Nitrate of soda, wood pulp and other ingredients are then added and the whole mass is thoroughly mixed, after which it is shoveled out and taken to another machine where the gelatin is squeezed into the paper shells as before.

The buildings in a dynamite factory are scattered over a large area, each danger building being kept at a predetermined distance from every other building and surrounded by a thick earth barricade. The men who work in the danger buildings are old, tried and trusted employees who have proved their reliability for some years before going into the danger area. As a result of all these precautions, the normal hazard of manufacture of high explosives compares very favorably with that of other large industrial operations, such as the big locomotive works and shipyards. Of course, an accident in a dynamite factory attracts more attention than one in other industries as it makes a good deal more noise.

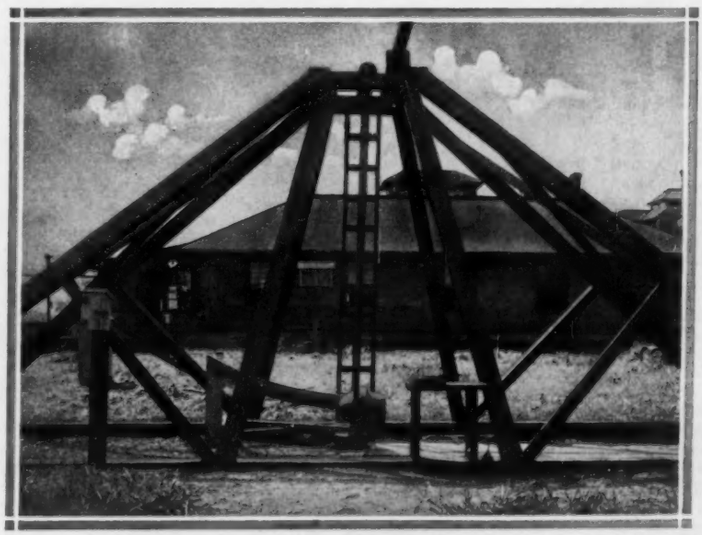
Deflagrating explosives of the black-powder and smokeless-powder types are fired by the impact of a flame or spark. In using black powder in blasting operations, this is usually accomplished by the spark from safety fuse or time fuse, which consists of a small train of powder tightly wrapped with windings of jute and cotton thread, with layers of waterproofing material, such as asphalt, gutta-percha, and rubber compounds, between the fabric layers. Safety fuse burns at 32 to 40 seconds per foot, depending on the type of fuse, whether it is standard or slow-burning.

Detonating explosives, of which dynamite is the most common type, require an intermediate agent known variously as a detonator or blasting cap. Blasting caps, in turn, are of two general kinds: those which are themselves fired by the end spit of a fuse and those which are fired by an electric current. The ordinary blasting caps consist of a cylinder of thin copper about one-quarter inch in diameter and one and one-half or two inches long, nearly filled with a sensitive mixture, generally fulminate of mercury and potash. This detonates with great violence from the spark emitted at the end of a fuse crimped in the cap, and when this cap is imbedded in dynamite or other high explosives, the dynamite is in turn detonated without any appreciable interval between the two explosives.

It is rather unsatisfactory to use cap and fuse under water or in wet holes, as there is always a chance that moisture will get into the cap and kill the sparks from the fuse. Cap and fuse also have the drawback that once the fuse starts to burn, it is out of control, and if the miner changes his mind, it is impossible to stop or delay the time of the blast. For this reason, electric firing is much more convenient and much safer.

An electric blasting cap consists of a blasting cap of slightly larger diameter in which the two lead wires with a platinum-wire bridge soldered across their

(Continued on page 286)



Mortar and pendulum arrangement for gaging the strength of explosives. The pendulum takes up the recoil, and the distance which it swings under this impulse gives the desired information

Chemistry and Preventive Dentistry

By C. C. Vogt
Industrial Fellow, Mellon Institute of Industrial Research

IT may seem a far cry from the noxious fumes of a chemical laboratory to the prevention of dental diseases, but the same fundamental scientific principles apply to the decaying of teeth as to the analysis of an ore sample—the only difference being in the method of application.

In studying the chemistry of the mouth naturally the composition and properties of saliva demand consideration. Saliva is secreted from the blood stream by the salivary glands and contains, in addition to a small quantity of inorganic salts, a water-soluble substance called mucin, which makes saliva stringy and causes it to froth.

The mucin is in solution in saliva as secreted, but when the saliva comes in contact with acid—the acid from one's morning grapefruit or dinner salad or from the bacterial fermentation of foods, for example—this soluble form of mucin is changed into an insoluble form of slightly differing composition, which separates out in the form of a gelatinous precipitate. The insoluble variety of mucin is quite adhesive and covers the teeth with a protective coating which prevents any fruit or other acid which may happen to be in the mouth from dissolving the enamel of the teeth.

But while these deposits of mucin are good in themselves, they should be removed frequently, thus permitting the formation of new ones—for Nature automatically renews this protection whenever acid encounters saliva.

One reason for cleaning the teeth is that in many cases the mucin adhering to them carries with it carbohydrates or other food debris and furnishes an ideal lodging place with meals thrown in for bacteria. There is always a superabundance of bacteria looking for a suitable home, so they quietly entrench themselves in the mucinous masses and there secrete lactic acid. This acid is held next the teeth by the closely clinging mucin, and in time it dissolves the enamel of the teeth. Then the persistent microorganisms invade the underlying dentin which supplies them with food in abundance, and from there they rapidly proceed to the pulp which contains the nerves of the tooth.

At this stage the neglectful owner of the tooth becomes painfully aware of the good old "ounce of prevention" adage and spends a few sleepless hours nursing "that tooth" and several anxious moments in the dentist's chair ruefully wishing that "I had listened to that dentist chap who told me to watch my teeth."

For it is the opinion of dentists that the mucinous deposits should be removed at frequent intervals, thus dislodging the bacteria and washing away the lactic acid formed by their activities. Such a precautionary measure would keep the acid from dissolving the enamel and would help in retarding dental decay if not in preventing it altogether.

Some lucky persons escape dental decay and boast of fine white teeth, but by and by a slight roughness along the gum-line begins to appear. This doesn't seem to be worth a moment's notice, but some fine morning the gums begin to bleed a bit when brushed—all due to the irritant action of an accumulation of unsightly tartar which has caused the bleeding. Soon thereafter the gums begin to recede and become inflamed, causing sufficient discomfort that finally the dentist is consulted—again after the mischief has been done.

The combined efforts of the dentist and the chemist have convicted mucin of being the arch criminal which causes these troubles as well as dental decay. In some mouths the insoluble mucin deposited on the teeth by the action of acids carries along with it some of the lime salts present in saliva. The nucleus so formed settles along the gum-line and clings to the tooth. Little by little successive layers of lime salts accumulate on this nucleus and the deposit grows and gets harder and harder. The gelatinous mucin is the substance which cements the lime salts together and fastens the calcareous material to the tooth.

In the early stages the deposits are soft and easily removed by proper methods, but after they begin to harden instrumentation soon becomes necessary. Here again dentists are certain that if the mucinous material is removed frequently the formation of tartar can be prevented. Obviously if tartar is not present, irritation with its harmful effects cannot occur.

Thus it will be seen that chemistry helps materially in explaining the causes of the two most common detail diseases.

Ever since the first historical records man has been trying to prevent dental disease. Some 3000 years B.C. the Egyptians record the following prescription for cleaning the teeth:

Powder of flint stones, 1 part;
"Green lead," 1 part;
Honey, 1 part.

Dentifrices of the present day may be divided into two general classes—those which depend upon the action of soap alone and those which depend upon the scrubbing action of an abrasive with or without soap for cleansing power. Various fruit acids, antiseptics and astringents have been advocated in the different preparations, but the abrasive is expected to do the actual cleaning.

The very multiplicity of dentifrices on the market seemed to indicate that something must be lacking. Therefore a study of the dentifrice problem was undertaken last year at the Mellon Institute of Industrial Research on the request of a Pittsburgh dentist, who, during twenty years of experience, had been led to believe that if a solvent for mucin could be discovered such a material would effectually solve the problem of the thorough cleaning of the teeth.

One method of dissolving mucin is so obvious that it almost escaped attention. If you will recall, first, that mucin is dissolved in the salivary glands by a secretion from the blood stream, thus forming saliva, and second, that it is rendered insoluble by acid in the mouth, then the logical method of dissolving mucin becomes apparent. Simply reverse the action of the acid by converting the insoluble type of the mucin as deposited on the teeth into a soluble form similar to that present in the salivary glands and then dissolve it by means of a solution similar to the blood stream in composition, in this way closely imitating the secretion of saliva. Fortunately it has been possible to do both these things with a single solution.

This is quite a radical departure from the pastes and the powders to which one has been accustomed, but in order to dissolve any substance two things are necessary. First, one must choose a solvent in which the substance may dissolve—sugar will not dissolve in sand, but does so readily in liquid water. Second, the substance itself must be soluble in the particular solvent used. Mucin as deposited on the teeth is not water soluble, but the mucin present in saliva is soluble, therefore one must change mucin into the soluble form before it will dissolve.

It has been found that a solution made in accord with the principles outlined above is an efficient solvent for mucin and that it does clean the teeth without the action of an abrasive. And it is believed that chemistry has found a way to help in the prevention of dental disease, first by assisting in discovering the cause, and then by showing how to remove that cause.

The frequent occurrence in current advertising matter of such words as pyorrhea and halitosis is indication of the serious attention being given by makers of dentifrices and other toilet articles to the scientific principles underlying their use. No longer are these products compounded by blind empiricism, and used or omitted through sheer habit. The maker knows why each ingredient goes in, and the user knows exactly what the finished product is doing in his bathroom.

Colloids and Your Health

By Ismar Ginsberg

IN ancient Egypt, the land where chemistry originated—the word chemistry is derived from Chêmi (Egypt)—the priests were both chemists and physicians, and experimented with simple chemicals in the treatment of disease. Most ancient scientists likewise, as well as those who flourished during the Dark and Middle Ages, were chemists as well as physicians and applied their chemical knowledge to the cure of various human afflictions. But this close relationship between medicine and chemistry did not endure, and it has been only very recently that it began again to be appreciated that chemistry could render great aid to the physician and physiologist. The progress that has been made up to the present time, since the physiological chemist began to occupy himself with the treatment of disease—a progress which has been very remarkable considering the short time of its duration—leads one to much speculation as to what our knowledge of how to cure disease would have been by this time if the modern chemist had turned his attention to medicine at the very start, or if the ancient close relation between chemistry and medicine had endured up to modern times.

It is evident on the face of it that chemistry and medicine are closely related sciences. The human body is but a chemical machine, in which various chemical reactions are performed, be it the digestion of the food as it passes through the alimentary tract or the absorption of oxygen by the blood or the combination of the odor-producing agents in the perfume with the odor-detecting units in the mucous membrane of the nose to produce the sensation of smell. If anything goes wrong with us—for example, if our digestion is bad and we have dyspepsia—it is because something has happened to disturb the smooth course of the chemical action of digestion. In a chemical plant if a process gets out of order the chemist is called in to correct it; the chemist can render important aid to the physician in correcting a deranged chemical process in the human organism.

So any important development in chemistry will have its significance in the treatment of disease. In recent years colloid chemistry has assumed the essential importance that it possessed, unknown to the chemist, ever since life came upon this earth. Sugar will dissolve in water to give a clear solution; so will salt. Sand or dirt or finely pulverized coal will remain suspended in water, but easily separable therefrom by filtration. The colloid stands somewhere in between. It is neither a solution like the first case nor a suspension like the second. The particles of the colloid are so fine that they will pass through the ordinary filtering medium. Many industrial products are colloidal in nature, such as rubber, milk, glue, gelatine, etc., etc.

Even at the very start Graham, the formulator of the fundamental principles of the science of colloidal chemistry, saw the importance of colloids to living matter in stating that "the colloidal state may be looked upon as the probable primary source of the force appearing in the phenomenon of vitality." Today it is generally accepted that all life processes take place in a colloidal system. This is a very important conception and the results that have been obtained in the treatment of disease, based on this principle, seem to indicate that the great future for chemistry in aiding the physician to cure human ailments is along colloidal chemical lines.

We all know how easily milk will sour due to the formation in it of lactic acid from the decomposition of the milk sugar, lactose. The same effect can be produced instantly by introducing a drop of acid into the milk. Coagulation takes place; the albumin in the milk is precipitated. The colloidal state of the milk is destroyed, and the same thing can be done with any colloidal solution. Examination of various fluids of the body have shown that they are all colloidal in nature; in fact, the muscles and tissues are also colloidal. A drop of acid in the blood will cause the albuminous matters held in suspension therein to coagulate; in fact, the blood will coagulate when exposed to the air, a fact to which we owe the stopping of blood from a cut—otherwise we would bleed to death from every scratch—as indeed an unfortunate few of us do whose blood is deficient in the coagulating agent. If we eat something that is bad for us, with the resulting formation of acid, which gets into the blood, there is produced a mild disturbance therein which makes us ill. If we inject acid into our veins we will die, for then complete coagulation results. Even so innocent a substance as ordinary white of egg has this effect, and it is substantially in this way that the deadly snake venoms do their work.

Inasmuch as all the fluids in the body are colloidal in nature, it is evident that anything that will impair this colloidal condition must be looked upon as a source of injury to us. In the handling of colloids in the chemical plant care must always be taken to guard against the introduction of electrolytes, that is, substances which conduct the electric current, into the process, as these substances will destroy the colloid. To remove them other substances are added. In the human body the colloidal condition is the natural condition of good health. Bad health and death are caused by the formation of products within the body, due to disease germs and other causes, which are detrimental to the maintenance of the healthy colloidal condition of the various fluids on which life depends. The proper treatment to get rid of these injurious substances is to use drugs which will promote the colloidal state and bring it back to its original status, and this is doubtless the way in which most drugs work.

Harvesting Sugar Cane by Machine

THE present annual sugar-cane crop of the world approximates 125 million tons, which is cut at varying seasons. The harvesting of sugar-cane consists of cutting the stalk off at the bottom, removing all the trash and cutting the green top off at the last ripe joint. This work is at present performed by hand, the cane-cutter being armed with a large machette or cane-knife, and the cane harvested one stalk at a time. The tremendous amount of work necessary to harvest the world's crop in this manner may be understood from the fact that this amount of cane contains from 45 to 50 billion individual stalks. Up to the present time there has been no machine available for this work, although sugar-cane has been utilized for many hundreds of years, and within the last century has come to be one of the world's most important crops.

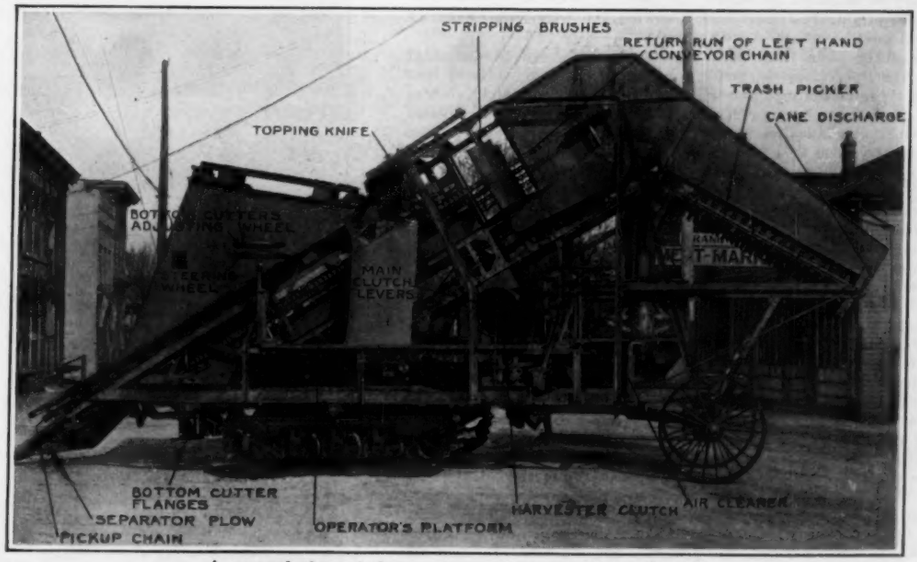
New Orleans is now interested in a machine which is being put forward for doing this work, and which seems to give far more promise of success than any previous device. The machine straddles the row of cane, harvesting one row at a time. The contrivance at the lower left-hand side of the front view is a separator plow, separating the adjacent row from the row on which the machine is operating. The machine is equipped with rearwardly moving pick-up chains on which are fastened the projecting pick-up fingers seen in this front view. The bottom cutters are circular disks which are fastened to the flanges at the bottom of the cutter shafts and, overlapping each other, rotate inwardly and sever the cane at or below the ground level.

As the cane is cut it is picked up by conveyor chains and begins its journey through the machine. The next operation is the topping, which is performed by straight knives, held in a rapidly revolving steel hub, which perform the double duty of severing the tops from the stalks and discharging them into the open field.

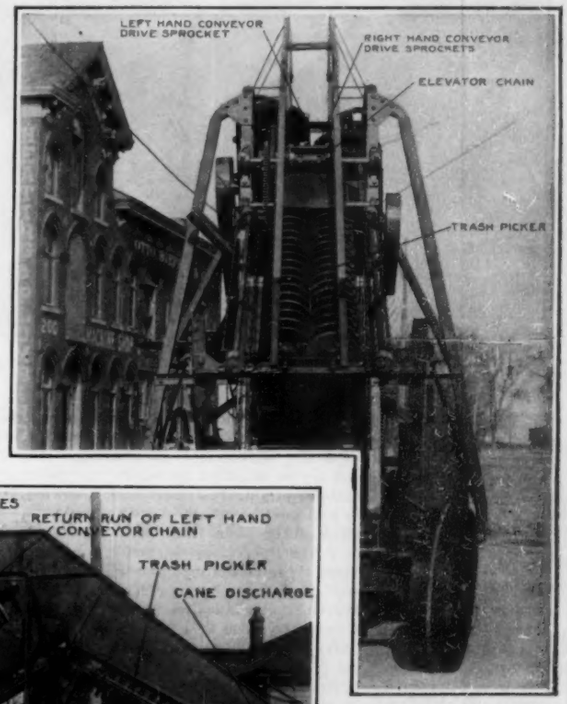
After the cane is topped, the stalks are carried past and between two stripping brushes, which are revolving in a direction opposite to that of the cane travel. These brushes are equipped with flexible wire stripping fingers, which effectively clean all the trash from the cane. The cane is discharged from the apparatus shown in the rear view and which is designed to trap any loose trash which otherwise would be discharged into the trailer. The clean cane slides over the rotating disks and the trash is effectively trapped between the disks and discharged by the rotating pickers on either side of the set.

In the model shown, the machine is carried on a combination of crawler type and round wheels. Steering is accomplished by the round wheels through a power device operated by the lower of the two end wheels shown at the front of the operating platform. Where the land is soft, such as, for instance, in the Florida Everglades, the round wheels are dispensed with and the machine is carried on two augmented flat wheels.

Front elevation of the harvester, showing the pick-up chains



A general view of the sugar-cane harvester from the side



Rear view of the machine

Making the Use of Gas in the Home, Safe

PROFESSOR YANDELL HENDERSON of Yale University, conducting an investigation for one of the large gas companies in New York City, has made recently two important steps in lessening the danger from the use of cooking or illuminating gas in the home.

The first step was the perfection of a method of resuscitation of victims overcome by gas, and the second was the introduction into the gas supply itself of a powerful odor so that a leak in the pipes would immediately be detected.

The method of resuscitation is a development of a method devised by Dr. Henderson and his assistant, Dr. Howard W. Haggard, to hasten relief from the effects of ether after an operation. In either case a poison has been taken into the system through the lungs, and it was considered by the investigators that the essential thing is to relieve the system of this poison as quickly as possible.

Experience has shown that relief from this poison can best be obtained through the same organ through which the poison entered the system—the lungs. When recovery is allowed to take its natural course, in pure air, it is slow, especially in the initial stages, for the breathing is slow, as in sleep.

An investigation has shown that the usual method of using a pulmotor is far from being satisfactory. In some cases actual injury is done by inexperienced handling of the apparatus and the results, at best, are uncertain.

It was found that carbon dioxide gas, administered in small measured quantities, has the effect of stimulating the involuntary nervous system which controls breathing and causes the patient to take long, deep breaths, even when the effects of the poison gas have proceeded far and the breathing is very faint.

To further assist in the resuscitation, oxygen is mixed with the carbon dioxide gas and the mixture is carried under high pressure in a heavy metal flask. The control apparatus consists merely of specially designed valves and expansion chambers. There is a face mask so designed that the small amount of gas used is drawn in with the regular air supply for breathing.

The use of this apparatus has proved so great an advance over other methods that a number of rescue squads maintained by the gas company are now working in New York City with remarkable success.

An even greater step, from the viewpoint of the user of gas, is the odor method of giving the alarm of a gas leak. Natural gas, the supply of which is rapidly diminishing and which is being replaced by a manufactured product, is rather odorous. A leak is likely to be discovered before there is a sufficient concentration to cause danger, but when such leaks occur at night it frequently happens that they are not discovered in time. The artificial gas, however, is not so odorous, and the danger of asphyxiation from it is consequently greater.

Dr. Henderson proposes to introduce into the gas supply a strong odor which would betray even a slight leak long before there was danger from it. The odor used is that of mercaptan, the odor which we commonly associate with the skunk, and one of the most powerful odors known. Experiment has shown that such small amounts as .0000004 milligram of the substance to one liter of air are perceptible. A single drop of mercaptan would be sufficient to odorize a space as large as the entire interior of the Woolworth Building, and only a few drops would be required to odorize the gas supply of a great city.

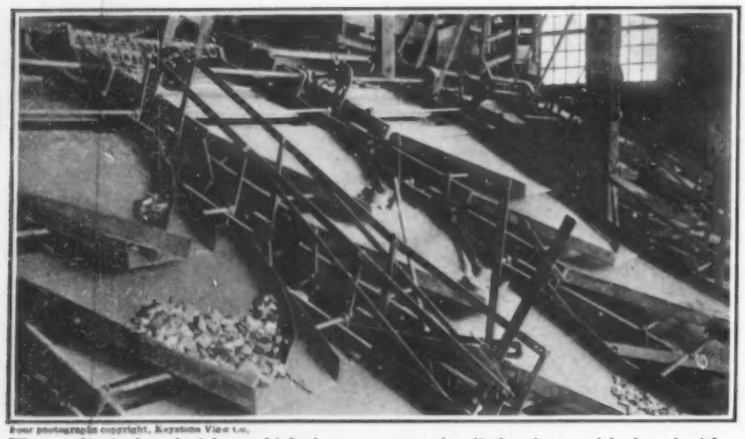
It has been shown that the process of burning the gas causes a chemical change in the mercaptan present so that it is no longer odorous. Thus as long as the gas supply system is working properly there will be no inconvenience from the presence of mercaptan in the gas supply. But if even a small amount of gas is allowed to escape without burning, that fact will be quickly detected.

It has been suggested that the introduction of such a scheme would have the effect of hastening repairs on a great number of minor leaks which now are not attended to because they are not great enough to cause serious discomfort, but which in the aggregate waste millions of feet of gas annually.

Various automatic shut-off devices have been suggested from time to time, but the introduction of mercaptan in our gas supply affords the simplest and surest method of gas leak detection yet proposed.

The Twenty-H

Why It Is Not Possible for the Coal Miner to Work S



Four photographs copyright, Keystone View Co.

The mechanical coal-picker, which throws out nearly all the slate and bad coal without the aid of human fingers

THAT coal comes out of the ground we all know; that it doesn't walk out of itself, but must, on the contrary, be brought out by human effort, is equally a matter of common information. But few of us realize the complicated series of steps by which the anthracite of our homes and the bituminous of our railroads and factories are won from Nature's storehouse and made available for our use.

Operations in a mine differ from those in a factory in one very fundamental respect. The man who works at a machine, under a roof and between walls of concrete and glass, stays right there at his machine while job after job is brought to him and taken away, finished. No matter how much work he does on this spot, he doesn't use up the spot; further work continues, right in the same place. In mining, on the other hand, when the first fifty feet of a vein have been worked out, the scene of operations has shifted fifty feet. This doesn't embarrass the worker immediately; he can pursue his job from place to place perfectly well, for it doesn't move faster than he does. But in the business of coordinating the work of the mine, the circumstance which we have brought to light is decisive. Imagine the plight of a works manager who was asked to supervise the making of millions of ball bearings, under a system where every machine moved five feet directly away from the center of the plant for every thousand balls it produced! Obvious enough when put in so many words, it is nevertheless the failure to visualize in a large way this fundamental distinction between mining and manufacture that is responsible for the difficulties in which the coal industry finds itself today.

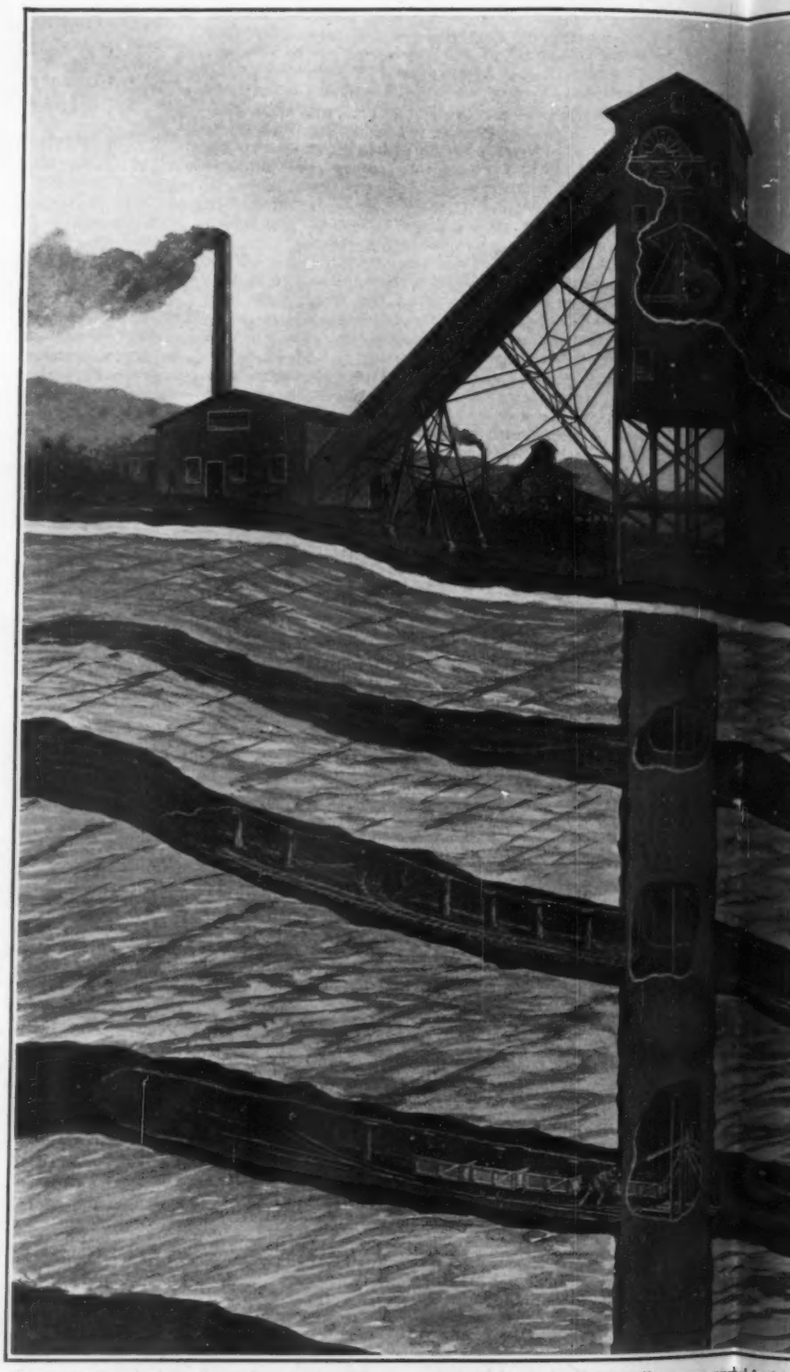
In a typical coal mine, where the vein does not outcrop and where it is therefore necessary to drive a vertical shaft down to the coal level or, perhaps, to the coal levels, mining commences from the foot of this shaft. Every ton of coal removed means that the next ton must be sought further from the shaft. Headings are driven in all directions, and out of these branch headings; coal being won out during this process, but only incidentally. It is from the working chambers, opening out of the galleries in long rows like tiny pigeonhole shops along an interminable street, that the real production is got. The galleries from which these chambers open are close together so that the chambers themselves can only be driven just so far back, when they must halt lest they break through into one another; and similarly they can be but just so wide. As they are worked out, the galleries are extended further and further out from the shaft and new chambers mined; the only limit is that imposed by ownership of the overlying land. Each year the distance which one must go through worked-out galleries in order to reach the live headings of the mine becomes greater.

The mere fact of itself might not be serious. But taken in connection with other necessary elements of coal mining it becomes so. Whether by pick or by machine, the getting of the coal is accomplished in substantially the same fashion. By machine if there is room for it to work in and by pick if there is not, an undercut is driven into the working face of the coal, flush with the floor of the working. In this explosives are placed; and when these are set off, the face of the coal crumbles down, tons at a time. This material may or may not have to be cleaned of its accompanying non-combustible rock on the spot. In either event, it must next be loaded upon mine-cars and hauled through the old galleries to the foot of the shaft. Raised thence to the surface, it must be loaded into railroad cars and carried away from the mine.

All this sounds simple enough—unpleasant, perhaps, but quite all right otherwise. And in very could undercut and blast and clean an and every day, he would be able, at pre with a very comfortable little fortune early age. But there's where the rub numerous reasons why he can't do that every-day trick.

In the first place, after he has made a few tons of coal on the floor of his ch naturally blocks the end of his heading. his next undercut until it has been remo perhaps, he could shovel it back to the e ber and thus get it out of his way. Pra

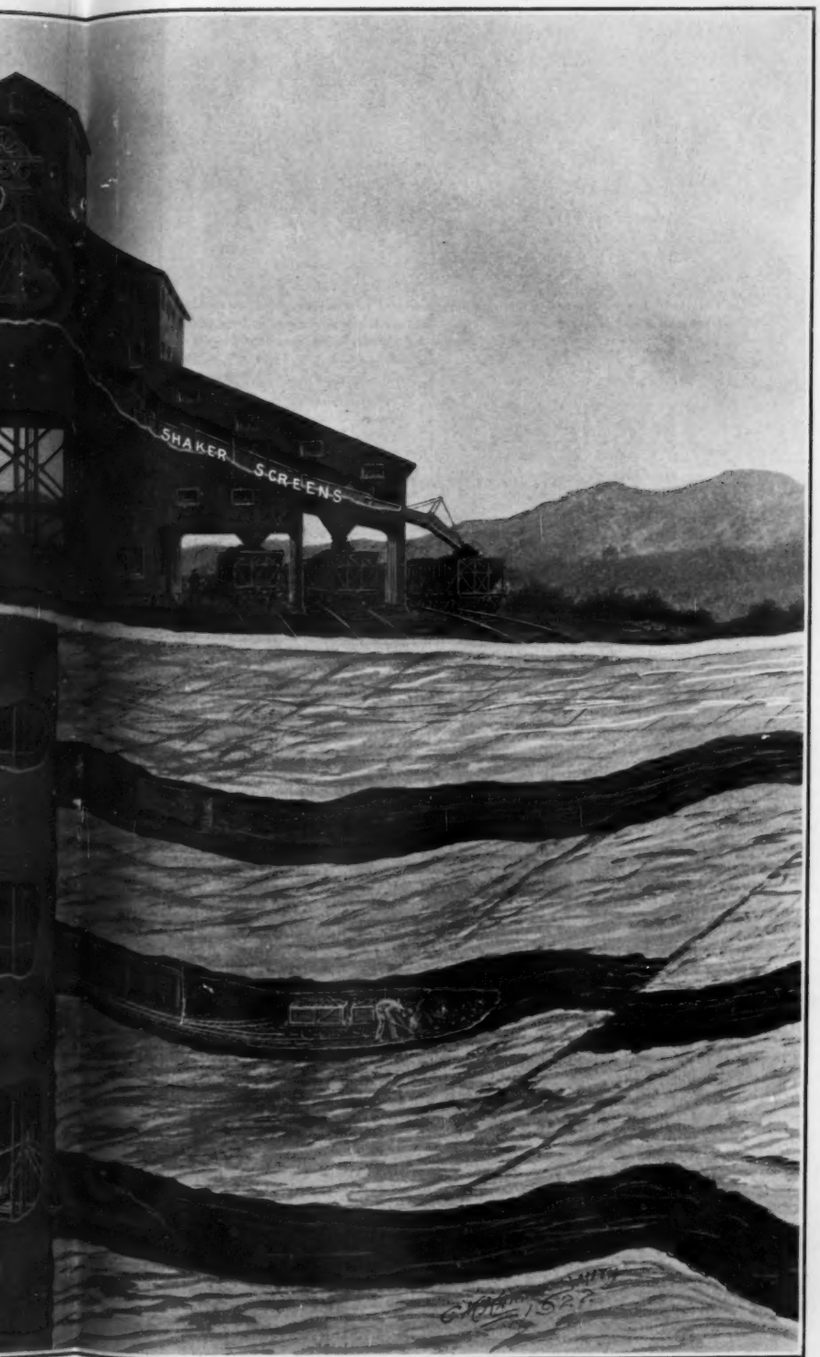
Coal just received at the surface from the mine. It is here being dumped at the top of the "breaker." After it has passed by gravity to the bottom of this building, it will have been sorted and picked over, and will be ready for shipment



Cross-sectional view through a coal mine of several levels. As the headings are pushed further opened out of them perpendicular to the plane of the paper. In order that the mine may be s undeveloped stage. In the second gallery, at the right, the

wenty-Hour Week

r to Work Steadily, and What This Means to the Industry

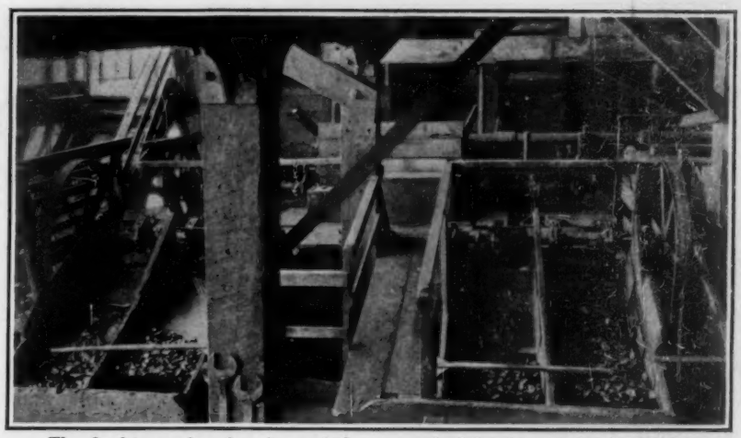


gs are pushed further from the shaft and more rock is available between them, workings will be at the mine may be shown on a sufficiently large scale, it is necessary to show it in a relatively ry, at the right, the ground has settled, producing a "fault."

herwise. And in very truth, if the miner nd blast and clean and load coal all day e would be able, at present rates, to retire fortable little fortune at a comparatively there's where the rub comes. There are why he can't do that steady, all-day-and-

face, after he has made his shot and spilled on the floor of his chamber, this material he end of his heading. He can't commence until it has been removed. Theoretically, shovel it back to the entrance of his cham- it out of his way. Practically, this means double handling; for in any event he must shovel it into a mine-car when one is available. Moreover, he is paid not when he knocks the coal down but when he delivers it to the shaft in a car; and there really wouldn't be much point, if no car was present to take away his ten tons, in piling up twenty or fifty tons—he would be just that much further in the hole. Once the blast has been shot, the miner must have a car into which to shovel his spoil before he can proceed.

And here is where the curious circumstances of the coal mine begin to get in their work. In the factory every man is in a large, light room, under the eye of his immediate superior. It is the definite business of that superior to see that every machine in his room is kept supplied with work and kept cleared of finished work; and there is not the least difficulty in his doing this. But suppose that the fifty lathes in a factory department were each in a little room of its own, completely shut off from all the others. Suppose the only way the foreman had of knowing how the fifty lathe-hands stood as regards supplies, work to do and finished work, was to make the tour of the fifty cubby-holes. Suppose this tour meant a four- or five-mile jaunt in utter darkness—in a darkness beside which nothing that we have in moonless nights at the surface of the earth can begin to qualify; and suppose that this cheerful journey had to be made with head continually bent and back continually bowed and knees continually crooked.



The final screening for size and the removal of foreign matter from coal before delivery to cars

Perhaps this crude and halting analogy will throw some light upon the plight in which the coal miner finds himself. In the very nature of things some mines are better run than others: some make every possible effort to insure that there shall be an empty car at every working face, every morning; some are very far indeed from this ideal. Striking a fair average, the chances are excellent that there will be no car when the miner reaches his heading. The chances, in fact, are excellent that the last car he loaded yesterday will not have been moved away.

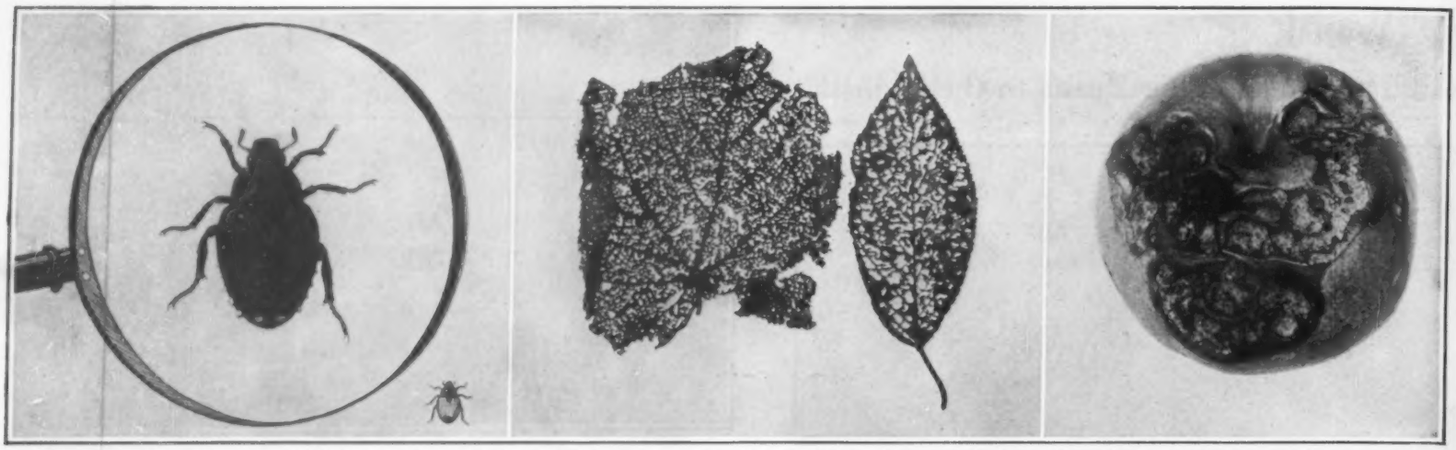
For the miner to go to the shaft to report that he has a full car or wants an empty one would be quite futile. In the first place, it took him an hour or thereabouts to get from the shaft to his job; if he then goes back to report his car needs, there will be three hours of his day gone by the time he is once more on the job. In the second place, if he does thus report his wants, he is little better off. He doesn't expect to find the foreman at the shaft; the foreman is making the tour of the mine. Even if he found someone at the shaft to whom he could report, his request cannot be acted upon promptly. The reason why there is no car at his particular heading is because all the cars are somewhere else; and what can the foreman, or anybody else at the shaft, do about it—in a hurry? He can go scouting for a car, of course, but here again the element of long distance and slow motion enters. All his experience tells the miner that the only thing for him to do when he gets to his working and finds no car is to shrug his shoulders and go home again. Better luck tomorrow—maybe!

On top of this there comes a further complication. Bituminous coal can be stored without deterioration only under water; and there is no room around the mine-mouth for immense storage pits. So bituminous—and even anthracite to a large extent, since space is at a premium near the mine—must be hauled away by the railroad just about as fast as it comes to the surface. And to haul it away, empty railroad cars must be at hand—"flats," as the miner calls them to distinguish them from his own smaller mine-cars.

Before the mine can start bringing up coal in the morning, a supply of flats sufficient to handle a respectable proportion of the day's output must be standing on the

(Continued on page 287)

A typical view showing the conditions at the working face of a coal heading. Note the considerable temporary structure necessary for the miner's safety, and the compressed-air power lines



Left: The green Japanese beetle, magnified about 4½ times, with the life-sized insect for comparison's sake. *Center:* Grape and elm leaves skeletonized by the beetle; when they are numerous, every leaf on the tree or vine looks like this. *Right:* Damage done an apple by the Japanese beetle; after the skin of the fruit is broken by the insect, decay quickly completes the story

The green Japanese beetle and some of his destructive work

The Green Japanese Beetle

New Jersey's Efforts to Subdue a New and Dangerous Pest

By William H. Cole, Lake Forest College, Lake Forest, Ill.

FOR several years past the United States and the New Jersey Governments have been carrying on an active war against the Green Japanese Beetle. The issue is not yet determined, although it is expected that the governments will win.

Sometime in August, 1916, about a dozen individuals of this insect, Popillia japonica, were discovered in a nursery near Riverton, Burlington County, N. J. The nursery had imported certain perennial plants, such as iris, azalea, etc., from Japan, previous to 1916, and it is supposed that the beetles in the larval or pupal form were introduced into the United States embedded in the soil about the roots of such plants. Because of the fact that this insect is not considered a dangerous pest in Japan, no steps were taken that year to prevent its spread. During the following summer, however, when the beetles had become well established over an area of 600 acres, the damage done by them to farm crops became apparent, but before sufficient funds could be appropriated either by the Federal or State Governments, the opportunity to begin defensive measures was passed. In 1918, when over 5000 acres had been infested, it was discovered that nearly every kind of farm and garden crop, as well as many kinds of trees and shrubs, are subject to attack by the insect. Observations made that year and since have shown that the following plants are most vigorously attacked:* Cultivated grape, raspberry, blackberry, apple, sweet cherry, sweet corn, soybean, red clover, Virginia creeper, rose, Althea, hollyhock, linden, American elm, white birch, white oak, willow and horse chestnut. Other plants attacked to a less degree include the plum, peach, quince, chestnut, Magnolia, asparagus, cantaloupe, beans, sweet potatoes, buckwheat, alfalfa, rye, timothy, azalea, iris, bridal wreath and honeysuckle. The beetle has also been found feeding on the foliage, flowers or fruit of over eighty other plants.

When the foliage is attacked the leaves are completely skeletonized, as shown in the illustration. Because they are negatively geotropic and positively phototropic, the beetles begin at the top of the tree or smaller plant and eat their way downward, leaving only the ribs of the leaves behind. This interference with photosynthesis greatly weakens the plant, and if repeated year after year in the case of perennials may cause the death of the plant. The damage done to flowers is not so serious, because not so widespread, as that done to foliage. But when many beetles collect on the blooms the reproductive structures are frequently damaged as well as the petals, so that the formation of fruit is imperfect. In corn the silk is eaten away, preventing fertilization and resulting in worthless ears. Some fruits, including the apple and peach, are seriously damaged, the breaking of the skin leading to quick decay, even if the substance of the fruit is not actually eaten. Each kind of damage becomes serious whenever a region is thoroughly infested, due to the large number of beetles present. As a result of the threatened danger to crops the two governments have spent over $150,000 since 1918.

The spread of the insect has been extremely rapid, rivaling that of the Colorado potato beetle years ago. By the summer of 1919 over 15,000 acres were infested as compared to 5000 in 1918, and in 1920 over four times as much territory had been covered, namely, 51,000 acres, or about 81 square miles. Beetles were found across the Delaware River in Pennsylvania, as well as near the city of Burlington, about fifteen miles northeast from the point of discovery in 1916. In 1921 approximately 270 square miles were infested, about 57 of which were in Pennsylvania and 213 in New Jersey. In other words, over 3.3 times as much ground was covered in 1921 as compared to that in 1920. If this rate of spread continues an area somewhat larger than the whole state of New Jersey will be infested by the summer of 1924, and by 1926 over 140,000 square miles will be covered, a region equal to the combined areas of New Jersey, Pennsylvania, New York, Maryland, Delaware, Connecticut, Rhode Island, Massachusetts and Vermont.

The life cycle of the beetle covers one year, most of which time is spent in the soil as an egg, a larva or a pupa. The eggs are laid during August and September. About two weeks afterward they hatch into the young larvae, which are voracious eaters, devouring the roots of many kinds of plants. As soon as the first cold weather comes the larvae burrow deeper into the soil, where they remain throughout the winter. In the spring the half-grown larvae return to activity and feed on roots close to the surface. By June growth is completed and pupation occurs, followed by the emergence of the imagos during July. For about six weeks the beetles are very active, especially on hot days, flying from place to place and constantly feeding. During this period the eggs of the female have matured, and at frequent intervals mating and fertilization, followed by egg-laying, occur. It has been estimated that each female lays about 60 eggs. Toward the end of September nearly all of the beetles have disappeared, and it is supposed that the adults perish, each summer witnessing a new generation.

The control measures taken by the governments working in conjunction have included the destruction of all non-economic plants within a half-mile band surrounding the infested area; the clearing of roadsides and headlands within the area; the strict quarantine of all produce shipped out of the region; the destruction of many adults by hand collecting; the poisoning of the soil by sodium cyanide wherever larvae are suspected; and the continued search for an efficient poison for the adult.

Hand collecting of beetles is done by boys, who are paid by the quart. In 1920 they brought in a daily average of five gallons, or a total of over 3,240,000 beetles for the season of eight weeks. (One quart contains about 3375 beetles.) This number represented about 97 million larvae of the next generation.

During the period of greatest activity of the beetle (July and August) a strict quarantine on all farm and garden produce in the infested region is enforced. Every article that is to be shipped out is carefully examined by government inspectors for the presence of the insect. Any lot of material found infested is thoroughly freed from the pest, or else is barred from shipment. Since Burlington County and the surrounding infested territory constitute an important source of all kinds of garden truck for Philadelphia, the amount of shipping is very large and the task of inspecting all produce is a huge one. It is to be expected that some producers will intentionally avoid the quarantine, and that others will be put to evident unnecessary trouble and delay. On the whole, however, the quarantine has been successful, due to the cooperation of the farmers and other producers concerned. Unquestionably the spread of the insect has been materially checked.

The processes of poisoning the larvae in the soil is becoming impracticable because of the large area now infested. For local treatment it is recommended and successful, but as a means of preventing the spread of the beetle, soil insecticides have been abandoned.

The discovery of an effective poison for the adult still awaits the future. Many of the common arsenical sprays are repellants but not killers; so that the problem is to find a mixture of an effective poison and an attractive material which may be easily, quickly and cheaply applied, which will adhere to foliage after application, and which will not harm the plants. Up to date no such mixture has been found, but the laboratory at Riverton reports that during the coming summer it hopes to be able to demonstrate . . . on a comparatively large scale a satisfactory poison spray.

What is needed at this time most of all is a larger appropriation from the Federal and State Governments, so that the investigation of the life history, habits and physiology of the beetle will not be hampered, as in the past, by a lack of funds. And since the insect is spreading so rapidly, as shown by the latest report, very serious damages to farm and garden crops can be avoided only by prompt as well as generous support of the laboratory at Riverton, N. J.

* See Circular No. 30, N. J. Dept. Agriculture, Feb., 1920.

1921's Road Bill

THE United States spent $600,000,000 for roads in 1921, according to estimates of the Bureau of Public Roads, United States Department of Agriculture. This sum was derived from the following sources: Local road bonds, 33 per cent; county, township, and district taxes, assessments, and appropriations, 14 per cent; State taxes and appropriations, 12 per cent; State road bonds, 7 per cent; motor vehicle license revenues, 19 per cent; Federal aid, 14 per cent; and miscellaneous sources, 1 per cent.

Speeding Up the Auto-Tag Industry

AKING automobile tags has become a business in itself. With the United tes requiring some 22,000,000 automo- tags a year, a new industry has wn up to supply this need which has e with the motor car.

In the past, different methods have n used by the manufacturers, but gen- lly four or five operations have been essary to cut the tag and stamp the merals on it. A St. Paul man, however, developed a machine that cuts and mps an automobile tag in one opera- n instead of four. The machine has n in operation for a year and a half, d has proved highly successful.

Under old methods, one operation was uired to cut the tag. Rounding the ers and punching the slots in the tag another operation. Stamping the fig- on the metal was a separate opera- . The dies had to be changed by , constituting a fourth operation.

he new machine, invented by Joseph Gieske, does all this in one operation. ing strip of metal is fed in, and the hine does the rest. The steel press es down, and when it rises, it leaves g complete in every detail, except for enamel.

The whole process is automatic. Even steel dies, which make the numbers the tags, change places automatically. er the old method, considerable time lost in changing the dies by hand. inventor of the new machine hit upon thod of avoiding this. He took a bar placed dies of the ten numerals on bar. When one tag is stamped, the slides up automatically, and the next ber comes into place. Instead of one, two sliding may be used, carrying dies for the two units of tag number, or even more bars may be used if it s desirable.

is sliding bar is one of the important features e new machine covered by patents. Another is the of what has been called the "double-end cut-off" nnection with the compressible dies. This device off round corners on the two adjoining ends when tag is severed from the strip of steel. This is at the time the tag is stamped.

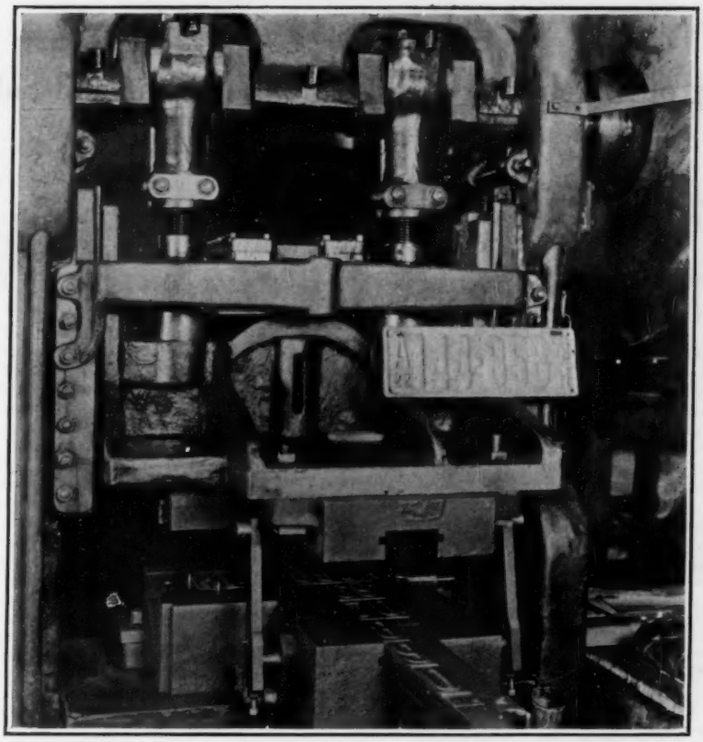
ong the other features of the machine covered by nts is the numbering device. By the simple use lever, the operator can control the transfer of the . Each machine will turn out 4000 tags in eight rs, and requires but one man to operate it.

fter the tags come from the stamping machine, they placed on racks in consecutive order. Each rack is dipped in a tank of specially prepared enamel he color selected for the body of the tag. When enamel has dripped from the plates, the racks are ed in a baking oven. There the tags are baked n hour and a half at a temperature of 250 degrees. e tags then go to a printing press. A flat-bed may be used. The rollers are covered with the el selected for the letters of the tag. As the rs pass over the tags, only the raised numbers ve this coat of enamel.

tags then are sent back e oven again. This time are baked for a half at a temperature of grees. This method or modification of it has used generally in the eling of the tags.

omobile tags usually made from what is d one-pass, cold-rolled , which has been treated an acid preparation to ine as far as possible ossibility of the enamel g off and opening a for rust.

e inventor estimates other things being the new stamping ma- enables him to cut off t from the cost of a The company holding ights to the patents a bid of 3¼ cents on one big contract recently, while the next lowest bid was 7 7/16 cents. This company is preparing to expand the capacity of its factory to 80,000 tags a day.



The machine that cuts out and stamps an automobile tag in one operation, leaving only the enameling to be done separately. The numbers shift automatically in the dies, and the machine turns out 500 tags per hour

Symbiosis in the Forest

THE dominant plants of a community, which in a forest are trees, are those which largely control the environment and so determine what other species may grow in the community. They have very important symbiotic relations, therefore, with all other members of the community through their direct or indirect control of light, space relations, water supply, and to a certain extent available food materials. From this point of view it is of interest to compare a plant community with a human community. In a human community man is the dominant species. As the dominant species he controls the environment to such an extent as to determine what other species may live in the community. Some of the other species usually found in a human community are the horse, dog, cat, mouse, fly, etc. Some of these are not present because man wants them to be, but because man is present and is controlling the environment in such a way as to make it possible for the other species to live in the community. These facts are just as true of the plant community. The presence of of some of the species is distinctly advantageous to the dominant plants, while that of others is just as distinctly disadvantageous, as, for example, the parasitic fungi, but they are all present because the dominant plants have made it possible by their control of the environment.

In the human community we find a well-marked division of labor among the individuals of the dominant species; some are engaged in supplying food, others in supplying clothes or fuel, others in administering the law, etc. In the plant community we find a somewhat comparable division of labor among the various species of the community, but not among the individuals of the dominant species. The function in the community of all members of the same species is the same, but some species have the function of manufacturing food, some for supplying a ground cover to check evaporation from the soil, some to act as scavengers in getting rid of dead bodies, etc.

Another important difference between the human community and the plant community should be kept in mind. In the human community there are ordinarily more or less definitely organized activities carried on for the good of the community as a whole. On the other hand, in the plant community there is no altruism. It is a case of every plant for itself. The activities of certain species do result advantageously for the community as a whole, but this is due to chance circumstances, and the activities of course would be carried on just as vigorously if they were resulting in harm to the community. This fundamental difference between the two communities, however, is the natural result of the presence of consciousness in the human species and the lack of it in plants, and as soon as we leave that fact out of consideration the two types of communities become strikingly similar.—Abstract from article by W. B. McDougall in the *Botanical Gazette* for March, 1922.

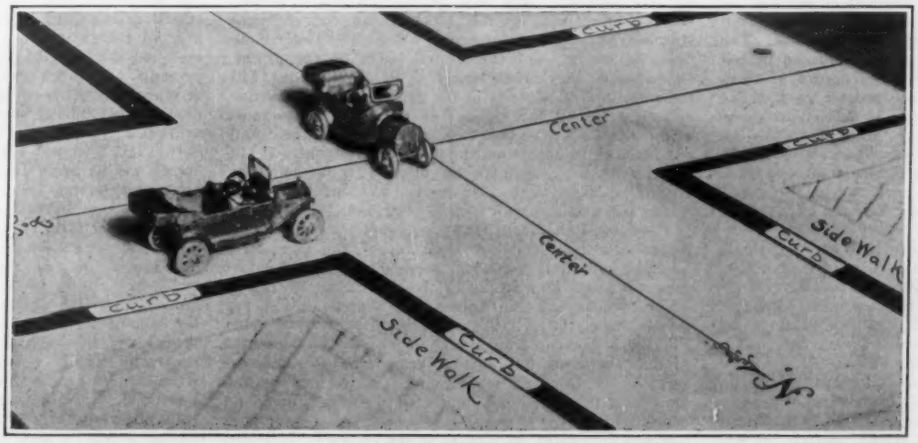
Graphic Testimony in Automobile Accident Cases

JUDGES of the two St. Louis police courts now base their decisions in motor vehicle accident cases on actual illustrations, with miniature automobiles and street cars, instead of the usual verbal testimony of witnesses. After a test of the new system, Judges George E. Mix and William B. Homer are convinced that it is a great time saver, is the most accurate method of explaining the circumstances of collisions, and does away with the necessity of employing interpreters for persons who cannot speak English.

Each witness is allowed to explain with the miniature autos and cars the relative positions of the vehicles figuring in an accident, and their position with regard to the street intersection or point of the collision. A cardboard chart one and a half feet square, on which the lines of a street intersection are drawn, is placed before the witness. He then illustrates to the judge, attorneys, and, if need be, to a jury, the relative positions of the vehicles. One man maneuvered the little instruments for several minutes and finally got himself into trouble. His illustration of the manner in which his car and another crashed together clearly showed that he was violating the traffic laws at the time, although he was unaware of the fact.

The device is the invention of Police Captain E. J. Phillips, assigned to special duty in police courts, who, after years of experimenting with such cases, concluded that erroneous impressions of the actual causes of motor accidents was often obtained from verbal testimony.

Judges Mix and Homer were unanimous in declaring that they were able to obtain a better perspective of cases by the new contrivance and that the business of the courts has been greatly facilitated.



Model automobiles and plan of a street intersection which are being used in a St. Louis traffic court for witnesses to reproduce the accident and its causes, as they saw them

The Microscopy of Foods

A Study of Starch, the World's Premier Alimental Substance

Leon Augustus Hausman, Ph.D., Cornell University

ONE of the commonest and most widely distributed of the cell contents of plants is starch, a substance which forms the chief food of the greater portion of the human race. It is found in all groups of plants, from the lowest to the highest, with the exception of the fungi, and its presence can be detected in nearly all parts of the plant body. Arising in the green, or chlorophyll-bearing organs, *i.e.*, principally stems and leaves, it is subsequently dissolved and transported to other portions of the plant destined to receive it. Here it may be stored temporarily, awaiting its use as material for rebuilding of tissues, or more permanently deposited as a reserve store. It is the presence of these starch-storehouses provided by many plants which make them valuable as sources of food: storehouses which we know under the names of seeds, tubers, rhizomes, fruits, etc.

Starch begins its growth in the green organs of the plant, chiefly in the leaves. The structure of a typical leaf is shown in Figure 4. The two epidermal layers of cells (layers 1 and 5) contain between them the active starch-producing and -transporting cells. The starch first makes its appearance in the chloroplasts, the minute green bodies which give color to the leaf, located within the palisade cells (layer 2). Beginning its growth as a minute corpuscle, the individual starch grain gradually increases in size until it may completely fill its generative choroplast. This first product of the chloroplast is known as *assimilation starch*, and may take various forms, existing as single grains or as aggregates within the cell. It is shortly changed into a soluble, sugar-like compound and is withdrawn from the palisade cells into the funnel cells (layer 3). From these it is conducted through the cells of the parenchyma (layer 4) into the vascular or circulatory system of the plant. As it passes from one cell into another it is alternately dissolved and redeposited. The starch thus interruptedly formed and reformed in cell after cell, during the translocation, is known as *transitory starch*. In many plants the greater part of the starch manufactured in the leaves is carried to seeds, fruits, and other storehouses where large quantities are accumulated. Such starch is termed *reserve starch*, and is the only form in which it is important as a food or commercial substance. Reserve starch is found chiefly in rhizomes (or thickened root-stocks), tubers, stems, fruits, and seeds.

The growth of starch in some plants is surprisingly rapid. The amount manufactured daily by a given area of leaf varies with the temperature, intensity of the light, and humidity, chiefly. It has been computed that the squash leaf, for example, can produce for every square yard of surface nearly three-quarters of an ounce of starch during a summer day of fifteen hours. During the same period a typical squash plant, bearing in the neighborhood of a hundred leaves, would produce over nine ounces of starch. Since sunlight is the stimulative factor in the starch forming activity of the chloroplasts, the greatest amount of starch is found in the leaf during the day, and the least during the night.

The following table shows the approximate percentages of starch in common food substances:

Wheat	61
Rye	57
Oats	35
Barley	64
Corn	65
Potatoes	25
Rice	76
Buckwheat	45

Although the starch grains in different species of plants differ markedly in their characteristics, yet all exhibit the same general structure. Figure 1 shows a typical starch grain, from the potato. The hilum, or "nucleus" of the grain (H) is the organic center, the point about which are built up, by successive deposition, the layers of granulose, a substance composing the greater portion of the starch grain. The position of these concentric layers is indicated, in the majority of starch grains, by the rings (R). Nägleli, in 1858, found that if potato starch be treated with saliva, at a temperature of 40 to 55 Centigrade, the granulose is dissolved, leaving a residual skeleton of cellulose. This latter substance has been termed *starch cellulose* to distinguish it from the ordinary woody cellulose which makes up the greater part of ordinary plant tissues.

The rings of starch grains may be either circular or eccentric, according to the location of the hilum. In corn, wheat and cassava starch (Fig. 7) the hilum is central, while in potato and the arrow roots it is eccentric in varying degrees.

While, as has been said, the general structural features of all starch grains are similar, yet there exist among starch grains from different species of plants, certain distinctive and characteristic features, individual modifications away from the generalized structure, which make possible the identification of different starches under the microscope. Some of these modifications lie in: (1) the growth-habit of the grains, *i.e.*, whether they occur singly or in aggregations, (2) the form and dimensions of the grains, (3) the position and character of the hilum, (4) form and distinctness of the rings, (5) the behavior of the grains with different types of illumination under the microscope, (6) the manner of the gelatinization of the grains on being heated in water, and (7) the behavior of the grains under the treatment of various reagents.

The growth-habit of the individual starch grains determines the form they shall take. The final form assumed by starch grains in the reserve organs of plants takes place in the leucoplasts of the organs. Within or around these cell-like bodies the starch grains are formed from the starch mother-liquid sent down from the leaf, a liquid of a sugar-like nature, the intermediate product between the various *transitory starches* described. If but one starch grain be formed in the leucoplast it will be globular, with a central hilum and concentric rings. If many grains are formed their final outlines will show the nature of the crowding to which they were subjected during their formation. Some grains may even be formed on the outside wall of the leucoplast, if the crowding is sufficiently acute.

It is frequently necessary, in analytical work, to determine the exact location of the hilum in starch grains, where it cannot be made out with ordinary microscopic examination. In such a case the grains are examined under polarized light. This consists in examining the grains with light vibrating in one plane only, and analyzed by means of an analyzer in the ocular of the microscope. Striking polarization phenomena are exhibited by many starch grains. The position of the hilum is indicated by the intersection of the dark lines appearing in the grain (Fig. 3).

The rings of most starch grains can be made out by shifting the substage mirror of the microscope to one side, and illuminating the grains with oblique light. If this fails the grains are then treated with a dilute solution of chromic acid.

When starch grains are treated with iodine the granulose stains blue, and the starch cellulose yellow. Since the former makes up the greater part of most grains, a deep blue color, of almost uniform distribution, is the characteristic appearance.

If starch is heated in water the grains undergo characteristic modifications, ending in gelatinization (Fig. 7). First the hilum fissures, the cracks running outward toward the edge in distinctive ways; then the central portion becomes granular, transparent, and finally the whole grain is distorted and swells into an amorphous mass. It is now gelatinized. If the solution is agitated the individual gelatinized grains disappear and the whole is converted into a uniform paste. Caustic potash, concentrated chloral hydrate, and concentrated calcium chloride likewise gelatinize starch. Strong hydrochloric and sulfuric acids dissolve it. It is important that the microanalyst should know of the various effects of these and other reagents upon starch grains from different species of plants, and be able to recognize the various starches in their many modified forms. In numerous powdered drugs, for example, the starch grains of their component vegetable mixtures are often changed by the heat, either moist or dry, applied during the different stages of their preparation.

In Figs. 5, 6 and 7 is shown the appearance of the starch grains from thirteen common foods, both raw and after having been brought to a boil. It will be seen that the characteristic appearance of the gelatinized or partially gelatinized grains can often be used as a criterion in assisting in determining the source of the starch. In many legumes, such as beans and lentils, boiling, even for several hours, fails to liberate the starch grains from the cells of the cotyledons. The cells, with their starch grains are, however, dissociated from one another as shown in Fig. 5. Green split peas, on the other hand, whose starch grains closely resemble those of beans and lentils, show a different reaction. The majority of the cells burst and the individual grains are liberated and partly or wholly gelatinized (Fig. 5). Such distinctive behaviors are of the greatest use in microanalysis. In the banana (Fig. 6) the starch grains are gelatinized

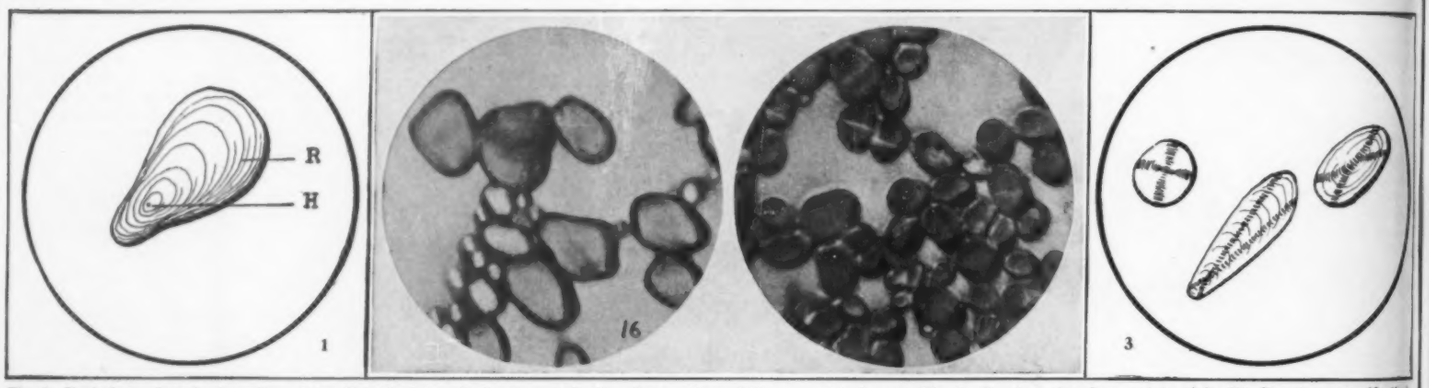


Fig. 1: Typical starch grain from the potato; H is the hilum, R the rings, indicating the positions of the concentric layers. Fig. 2: Starch grains from potato (left, 260 diameters magnification) and Lima bean (right, 320x), as they appear photomicrographically. Fig. 3: Characteristic appearance of wheat starch (left), bean starch (right) and curcuma starch (center), under polarized light. The position of the hilum is indicated at the junction of the dark lines

Drawings and photographs showing characteristic features of common starches

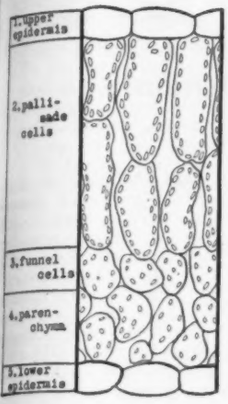


Fig. 4: Diagrammatic section through a green leaf, showing the plant's starch factory

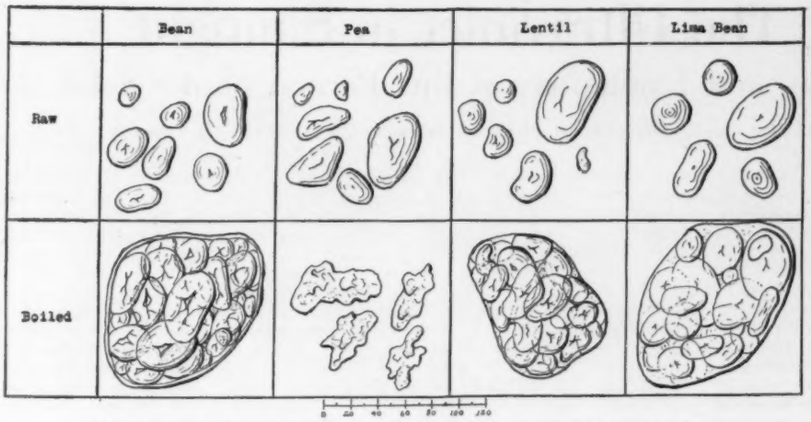


Fig. 5: Starch grains from several common sources, as they appear before and after cooking. The scale is marked off in microns (one micron equals one-millionth of a meter, or approximately .00004 inch)

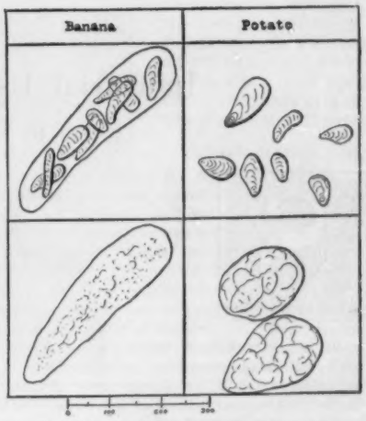


Fig. 6: A similar diagram, on a much larger scale, of banana and potato starches

Starch grains from numerous familiar vegetables, and the way in which they are produced

and disorganized within the cells of the fruit. Buckwheat, rice, and oats, when brought to a boil, liberate their starch grains from the cells. Those so liberated are gelatinized and disseminated throughout the water, forming a homogeneous paste. Such gelatinization may be termed disruptive (Fig. 7). Different starches gelatinize at different temperatures. In some cases these temperatures are of sufficient degrees of difference to form a basis of distinction. Whitmack, in 1887, on this principle, based a method for the detection of admixtures of wheat and rye flours. He found that while rye starch gelatinized at 55 Centigrade, it took a temperature 67.5 to produce the same result with wheat. Rice starch gelatinizes at 61.2; potato at 62.5; arrowroot (Maranta) at 70; and buckwheat at 71.7. Microscopic examination of the starch grains at various stages in the process of gelatinization reveals the fact that many grains show distinctive characteristics of behavior. In the microscopic study of the starches the method of preparation of samples commonly employed is simple. It consists in scraping or pounding a small portion of the sample into fine powder, if it be not already in that condition, mounting it in a drop of water, covering with a cover-glass and examining by ordinary transmitted light. Staining, gelatinizing, and otherwise treating with various reagents; examining by oblique, reflected, polarized or chromatic light, or by dark-field illumination; measuring, photographing and manipulating in a dozen and one ways familiar to the microscopist may likewise be necessary or helpful, particularly in the analysis of compounds.

With transmitted light, *i.e.*, light thrown up through the specimen from beneath, objects appear black upon a white ground (Figs. 5 to 7). Another type of illumination, known as dark-field illumination, illuminates the object only, the background, or field, remaining unlighted and hence black. Such illumination, for which specially made objectives and substage condenser are necessary, is useful in the accurate determination of very minute objects or structures. In another type of illumination the light is thrown down upon the specimen from above, illuminating especially the upper surface. If a piece of black velvet be used under the slide containing the object under examination, the latter will appear white upon a black ground, an appearance similar to the one secured by the dark-field type of lighting just mentioned. Such lighting is known as reflected lighting.

Numerous devices are in use for drawing microscopic objects. One much used is known as the camera lucida. A mirror is so arranged at the ocular of the microscope that when the eye is placed just above it an image of the object on the microscope stage is seen apparently superimposed upon the paper laid by the side of the microscope. Its outline and general features can then be accurately traced. Other devices in use by the writer must be reserved for description at a later date.

An ideal method of delineating microscopic objects is by photography, or photomicrography as it is called. For such work the best of lenses, both in the camera and the microscope, must be had. It is frequently necessary to use lights of different colors to bring out the various structures in a specimen. Space will not permit of the discussion of the various apparatus and methods used. It may be pointed out, however, that photomicrography is successful only with low or moderate magnifying powers, or with high powers when the specimen is fairly flat, *i.e.*, presents the parts to be delineated in nearly the same focal plane. With the high powers, even with objectives of great depth of focus, it is impossible to represent sharply in focus, upon the *flat* surface of the photographic plate, those features of structure or of marking which exist upon the *curved* surface of the specimen. Hence photomicrography is not entirely satisfactory in the study of objects of spherical, cylindrical, or other similar form. For the study of the starches photomicrographs are valuable chiefly in bringing out the comparative forms and dimensions of the individual grains (Fig. 2).

The accurate study of the microscopic characters of the grains of the various commercial and food starches enables one: (1) to determine the source of the different varieties of starch, (2) to distinguish various starch-containing compounds from one another, (3) to determine the percentages of the various starches used in compounds, and (4) to detect adulteration where starch (or a compound containing it) has been used as an adulterant.

Production of Rust by Carbonic Acid

ATTENTION has recently been drawn by G. Bruhn (see *Chem.-Zeitung*, No. 111) to a fact of great importance from an engineering point of view, viz., that the piping of heating plants is bound to be destroyed by free carbonic acid, as this, in conjunction with high-pressure steam, comes into contact with iron. This phenomenon is especially dangerous in case the boilers are fed with condensed water, which, of course, contains no carbonic acid salts. In fact, in the absence of such salts there is formed from carbon dioxide and water, according to the laws of the ionic theory, a far greater quantity of carbonic acid than in the event of carbonates being present.

The danger connected with the use of distilled water has, of course, long been known from actual practice, though the reason had not yet been found. The action of free carbonic acid is mainly due to bicarbonates being decomposed on heating the water. Bicarbonate of iron is, at first, produced from acid and iron, which on being heated absorbs oxygen from the water, thus being decomposed into iron oxide (settling as mud) and free carbonic acid, which, in its turn, will start anew the same process.

While this harmful action is observed wherever steam is allowed to enter, it is never noted below the waterline, where there is no free carbonic acid. Even worse is the effect due to the presence of chlorigenous substances, which, in conjunction with carbonic acid, will give rise to the production of free hydrochloric acid. Moreover, carbonic acid has been found to dissolve the copper and lead out of boiler fittings, which, in its turn, is bound to result in further damage of the iron, the galvanic cells formed by iron and the various other metals accelerating the rusting. The free carbonic acid problem should, accordingly, be studied with the greatest care.

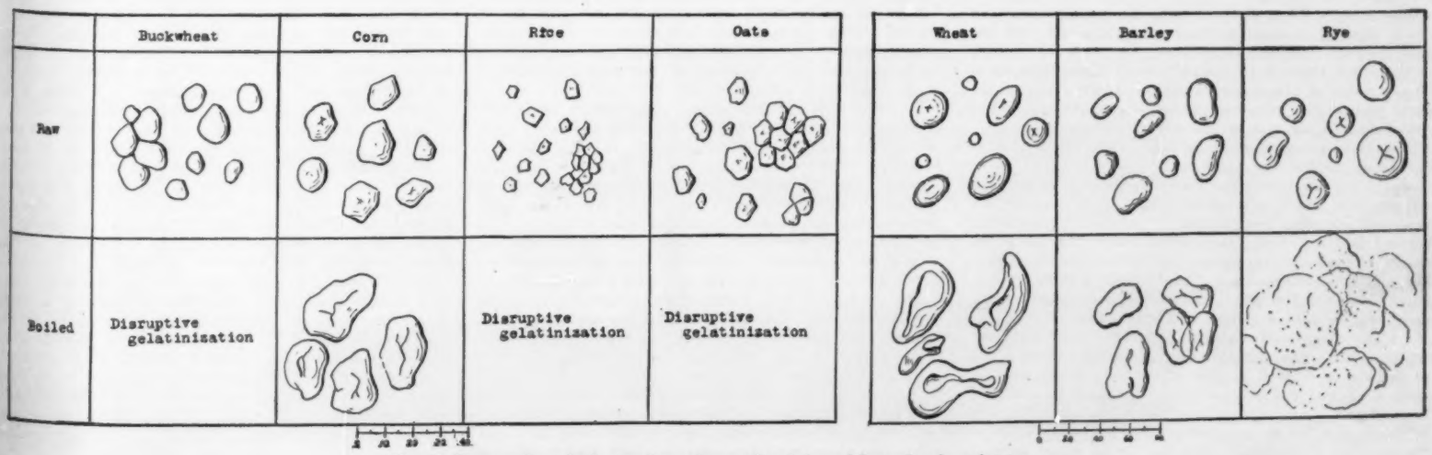


Fig. 7: Raw and cooked starches of cereal origin, with scales in microns

The Ultraviolet in Sunlight

Industrial Uses and Limitations of this Portion of the Solar Radiation

By M. Luckiesh, Director of Applied Science, Nela Research Laboratories

SOLAR radiation is a very important factor in many chemical reactions and is more or less a standard in many respects. The testing of paints and dyes, the bleaching of textiles, the "curing" of many products, various photographic processes, and a multitude of other photo-chemical reactions have been solely dependent upon solar radiation until recent years. However, with the development of sources rich in ultraviolet radiation artificial radiants have gradually replaced daylight in many industrial activities. Solar radiation has the advantage of great quantity but also the great disadvantage of undependability. At best the processes in which solar radiation is used must be discontinued during the night and cloudy and rainy days are disappointing. For this reason artificial illuminants rich in radiation of short wavelengths, such as the quartz mercury arc, the carbon arc, and the newer flame-arcs are welcomed with enthusiasm.

But there are pitfalls, inasmuch as the spectral character, and particularly the spectral range of the radiation from the artificial sources differ so materially from that of solar radiation. For example, in the testing of paints and dyes for permanency, results similar to those obtained with sunlight are of interest. Under ordinary conditions the foe of paints and dyes is daylight, for artificial illumination is rarely sufficiently intense to have a marked effect upon their permanency. It is desirable to test these materials under artificial radiation of constant intensity provided the spectral characteristics of the radiation is similar to that of sunlight. In respect to this point the spectral range of the radiation is of much more importance than the spectral distribution if the spectrum throughout the desired range is well represented by radiation.

The extent and chemical activity of the solar spectrum is also of importance, for sometimes the problem arises of limiting the daylight, which enters interiors, to the spectral rays having no detrimental effects. For example, in art museums delicate paintings and other art objects are faded by the daylight which enters. The glass manufacturers can serve well in this and in allied problems by producing an inexpensive colorless glass which does not transmit the more active radiations.

One of the surprising features of solar radiation is the abrupt ending of the spectrum in the ultraviolet region just shorter than 300 mμ. The temperature of the sun is much higher than the temperatures of our artificial radiants and it would be expected that its spectrum would extend to the very shortest wavelengths, but it does not. The spectrum of a quartz mercury arc extends to the limit of transmission of quartz—about 185 mμ. The spectrum of an iron arc in air extends to the very short wavelengths, although readily showing the absorption bands of oxygen in the region of 185 mμ.

The energy from the sun may be considered to be about equally divided between the infra-red and the visible (plus ultraviolet) regions. Our beloved pioneer in this field, Prof. S. P. Langley, determined that about 60 per cent of the sun's radiation which reached the earth was in the infra-red region, the remaining 40 per cent being in the visible and ultraviolet.

The visible region extends approximately from 760 mμ (red) to 400 mμ (violet). For the sake of clearness the author terms the region between 400 mμ and 300 mμ the "near" ultraviolet; the region between 300 mμ and 200 mμ, the "middle" ultraviolet; and that beyond 200 mμ, the "far" ultraviolet. An extensive usage has shown the great usefulness and practicability of this terminology. For example, ordinary glass transmits only the near ultraviolet; quartz, both the near and middle regions; and the practical range of the solar ultraviolet radiation includes only the near region. Thus photographic action through glass plates or lenses is limited to the near ultraviolet and the portion of the visible spectrum to which the emulsion is sensitive.

There can be no generalization such as "actinic," "active," or "chemical" rays, for these apply only to the particular reaction. Just as the human eyes of many lower organisms are not sensitive to the same range, so the many photo-chemical reactions differ widely in their response to various regions of the ultraviolet spectrum.

But to come back to solar radiation, we need not consider any of the ultraviolet spectrum excepting in the near region. If we use a quartz or reflection-grating spectrograph and photograph the spectrum of sunlight or of skylight by the side of an iron arc or a quartz arc, we find the spectrum of the latter strung out far into the ultraviolet beyond the point at which the daylight spectra stop abruptly. If we repeat the experiment but interpose a sheet of clear glass between the radiants and the spectrograph, we find the spectra of approximately the same length and slightly shorter than the daylight spectra in the first case. Among other things this shows that skylight and sunlight contain some radiation of such wavelengths as are powerfully absorbed by ordinary glass. In fact the absorption of ordinary clear glasses differs considerably, but in general it does not begin appreciably until about 350 mμ, but becomes practically complete at about 300 mμ.

It must have been a surprise to the first person who photographed the solar spectrum to find this abrupt ending at a little less than 300 mμ for radiation from a body at such a high temperature as the sun—more than 10,000 degrees Fahrenheit. In the light of present knowledge this would have been interpreted as indicating a selective atmospheric absorption. If that first experimenter had arrived at this conclusion and then proceeded to prove it by photographing the solar spectrum at different vertical altitudes he would have been even more surprised to find that ordinary heights made scarcely any difference. At noon under usual conditions the practical limit of the solar spectrum is near 295 mμ. By careful photography about 292 mμ can often be photographed, and this limit is not extended appreciably when the solar spectrum is photographed from an altitude three miles higher. At an altitude of 30,000 feet Wigand found the last indication of photographic action at 289.7 mμ. Dember, using a quartz spectrophotometer and a photo-electric cell at an altitude of 15,000 feet, found a limit of 280 mμ. This can be readily accounted for by the great sensitiveness of the photo-electric cell, but the value has not been confirmed by others. At any rate the practical limit is certainly about 295 mμ.

The selectivity of the dirty lower layers of atmosphere is easily shown by photographing the solar spectrum from a given point at different hours of the day. When at noon the limit of the spectrogram is about 295 mμ, at 3 P. M. it may be 300 mμ, and at 5 P. M. it may be about 310 mμ. Of course, this varies with the atmospheric conditions, but in general agrees with the visual observations. As the sun sinks into the west it becomes redder, indicating that the lower atmosphere absorbs the radiations of shorter wavelengths to a greater extent than those of the longer wavelengths.

Naturally this sudden ending of the solar spectrum when it should extend to the extremely short wavelengths became the subject of many researches and still the last word has not been uttered in this regard. Experiments were directed toward determining the absorption of the various gases of the atmosphere. Hartley photographed the spectrum of the quartz mercury arc at a horizontal distance of four miles and found it to extend to at least 254 mμ. He photographed the spectrum of cadmium at a distance of 3000 feet and found it to extend to about 231 mμ. These results are what would be expected when vertical heights as great as 30,000 feet were found not to increase appreciably the limit of the solar spectrum.

Various experimenters studied the absorption of nitrogen, oxygen, and other gases and finally ozone appeared to have the proper absorption band to account for the shortening of the solar spectrum. The maximum of the absorption band of ozone is at 255 mμ and the absorption is quite marked between 200 mμ and 290 mμ. But experiments indicate that a much greater proportion of ozone than exists in the lower atmosphere must be necessary to account for the limit of the solar spectrum. However, ozone does appear to be present in greater proportions at the higher altitudes investigated. The question remained unanswered beyond this, but it appears that ozone is accountable for limiting the extent of the solar spectrum in the ultraviolet region. Of course, it is possible that much of the absorption takes place in the sun's atmosphere.

In considering daylight photo-chemically, three distinct kinds must be recognized: (1) direct solar radiation, (2) sky radiation, and (3) radiation reflected from the earth, buildings, etc. The relative amounts of energy of various wavelengths of direct solar radiation are approximately equal throughout the visible region and well toward 300 mμ in the ultraviolet. The relative amounts of sky radiation of various wavelengths increases from the red to the blue region. From this point the relative energy begins to decrease gradually and abruptly ends as direct solar radiation does. The light from the total hemisphere of sky on clear days is from 10 to 20 per cent of the total daylight reaching the earth. The percentage increases with haziness. In general, ultraviolet radiation suffers considerable absorption by reflecting surfaces. Even white surfaces differ appreciably in their ability to reflect ultraviolet radiation. This point is very important in utilizing ultraviolet radiation in industrial processes.

It has been seen that the extent of the ultraviolet spectrum of daylight is limited to the near region, although it extends far enough to be effective in many photo-chemical reactions. In order to obtain comparable results with artificial radiants, the spectra of the latter must be limited in the same manner. This can be done sufficiently approximately by interposing a thin piece of ordinary glass. This question arises in many cases such as in paint and dye testing, in germicidal studies, in horticultural experiments, and in the "curing" of many products.

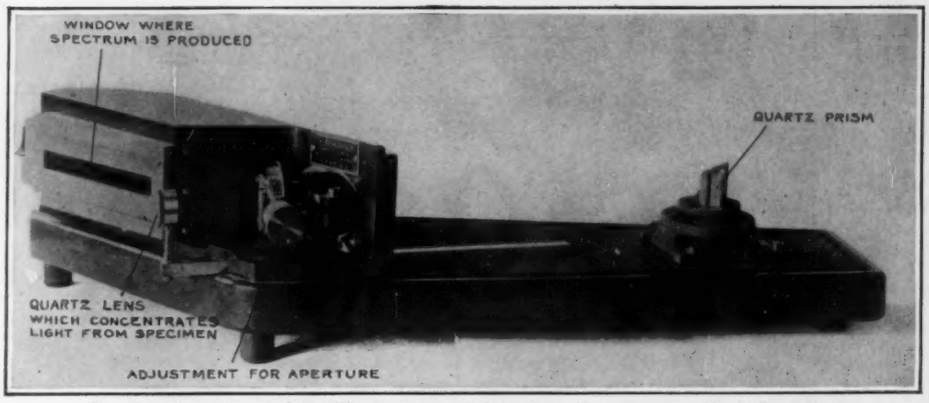
On the other hand, the greater spectral extent of artificial radiants makes them useful in many photo-chemical reactions where solar radiation fails. For example, lithopone, a pigment much used in white paints, sometimes has the fatal quality of turning black in the sunlight. Manufacturers used to test their various batches in sunlight, but during the long winter months in cloudy regions their product accumulated without being tested for lack of powerful sunlight. A quartz mercury arc was focussed by means of a quartz lens with the result that blackening was obtained in the case of an unsatisfactory batch in a few minutes, whereas it took an hour or more in June sunlight. Thus an artificial radiant solved the problems, and the procedure adopted as a makeshift was found advantageous for use at all times and in all seasons. Indeed, following this lead, it is now customary to make all light-resistance tests, in a fraction of the time formerly required, by utilizing an "artificial sunlight" of extreme intensity in the particular spectral regions that are decisive for the purpose in hand. But care must be exercised here; for many errors have been made by not taking into consideration the difference in the spectral extent of the artificial radiant from that of sunlight or skylight. The foregoing information is sufficient to avoid the chief pitfalls, but it is always easy to have tests made of materials and of radiants by means of a quartz spectrograph.

YOUR average human being is an "eye-minded" person, given to believing what he can see and doubting what he cannot; and the veneer of education which civilization has spread over us is not always sufficient to keep this tendency from cropping out at the surface. We all know that the visible spectrum is not the whole, that below the red and above the violet there are wave-lengths that do not affect the eye; and we ought to realize that, blind as are our eyes to these radiations, they must affect many things upon which they fall. But so far as we know, Mr. Luckiesh's article herewith is the first attempt made to tell us just what the ultraviolet section of the sun's radiated energy does, and how, and why.—THE EDITOR.

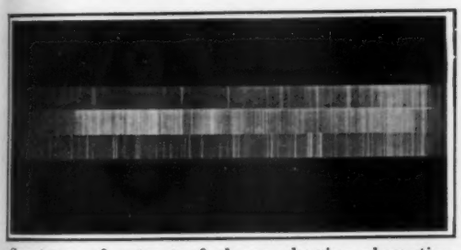
Practical Uses for the Spectroscope

FEW of us are so lacking in imagination that we do not get a thrill out of our first acquaintance with the spectroscope. The mere idea of projecting our inquiring minds across the billions of miles separating us from the stars, and making these luminaries yield up the secrets of their chemical constitution, their temperatures, their real brightnesses, their velocities, cannot but appeal to the mind. The process of analyzing the light which comes to us from these remote stars is, in itself, once granted the essential background of knowledge of the behavior of light in emission, in absorption and in refraction, so direct and simple that a further appeal is added. But until recent years it has been possible for the cold-blooded, unimaginative person to turn the spectroscope aside with a laugh; to say "Yes, very pretty; but what is the practical good?"

The trouble with the practical application of spectroscopy here on earth has always been that it is essentially a qualitative instrument and not a quantitative one. The possibilities of using it in chemical analysis are apparent; but what can one do with an instrument that tells merely of the presence of iron or tin or lead, without giving any indication of their amounts? Attempts to overcome their deficiency have been made, to be sure, and have been more or less satisfactory; but the spectroscope has not been able to compete with the more conventional means of analysis at the chemist's disposal. Now, however, with the introduction of apparatus designed by Auger and Fery, two French scientists, the spectroscope appears to be on the verge of coming into general practical application.


WINDOW WHERE SPECTRUM IS PRODUCED
QUARTZ PRISM
QUARTZ LENS WHICH CONCENTRATES LIGHT FROM SPECIMEN
ADJUSTMENT FOR APERTURE

The Fery "spectrograph," with cover removed to show the arrangement of the prisms

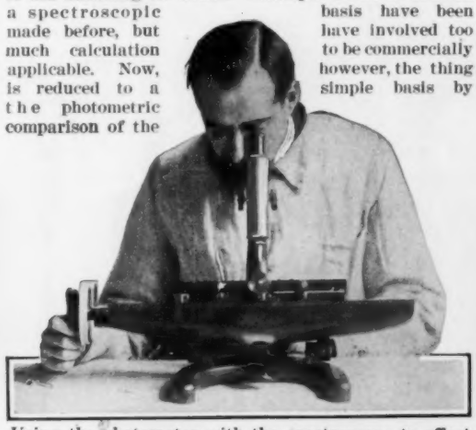


Spectrum of extract of cloves, showing absorption bands

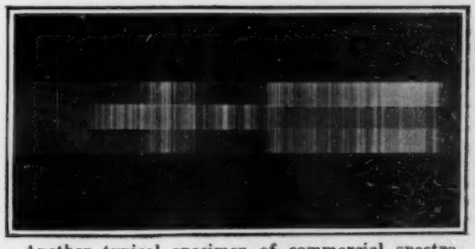
The essential feature of the new apparatus is the combination of the spectroscope with the photometer. It is granted that the presence of any element or any compound in the substance through which light is passed will lead to dark bands at certain points in the spectrum. It is granted that the more there is of this substance, the deeper will be these bands. But no simple rule exists for saying just what the relation between amount and intensity is, and in fact one cannot be sufficiently sure of the purity of the light source to have confidence in such a fixed, invariant rule if one were offered.

Auger and Fery, therefore, proceed on a basis of strict comparison. Their method is aimed at, and peculiarly adapted for use in, the determination of the proportions in which certain constituents are present in a mixture. Perfumes, for instance, constitute one of their fields of interest—when is the amount of the activating substance just right? The procedure adopted calls for the possession of a sample, in which this amount *is* just right. Light of any color may be used, and the color is selected with a view to the location of the particular dark bands of the particular substance being tested for, so that these shall be brought out to the best advantage. The bands from the control and those from the material being tested are compared in the photometer; it is noted how much of the substance tested for has to be added to bring the test sample up to par with the control sample; this is worked out on a basis of volume per cent or of mass per cent, the volume and the mass of the test sample being known; and the entire batch of material from which this sample was taken receives the same percentage addition of the activating agent that the sample received in the test.

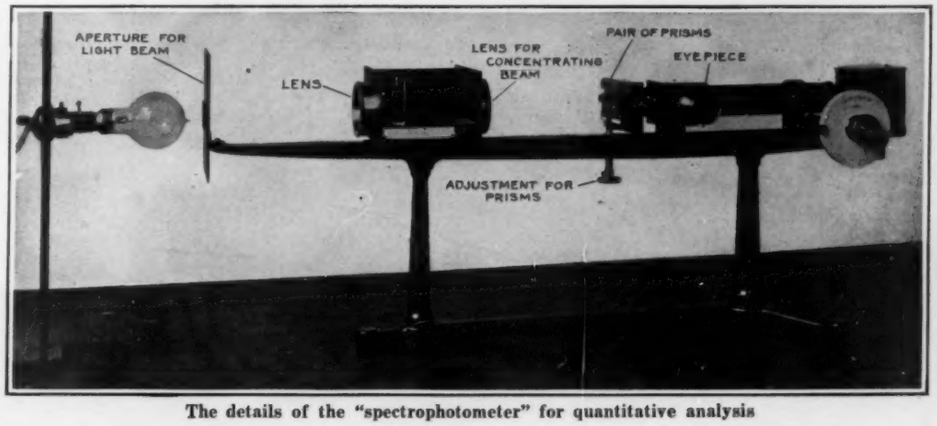
Another difficult process made easy by the new device is the matching of colors. Attempts to effect this on a spectroscopic basis have been made before, but have involved too much calculation to be commercially applicable. Now, however, the thing is reduced to a simple basis by the photometric comparison of the spectra from the two samples. In this application it is found often convenient to work with the ultraviolet rather than with the ordinary visible spectrum. Particular interest in the color test by the new apparatus revolves about its use in testing essential oils. Both in this application and in the one previously mentioned, M. Fery is now working toward an arrangement which will make it possible to replace visual photometric comparison by photographic comparison. Another useful suggestion is contained in the statement that the copper-sulfate content of canned peas has been tested in this manner, with an accuracy of .05 milligram per liter—an accuracy of something like one part in two hundred thousand. If the spectroscope can do this it can compete with any ordinary technique of commercial analysis, and its place in the chemistry of industry would seem to be assured.



Using the photometer with the spectroscope to effect chemical control of manufacturing processes



Another typical specimen of commercial spectrophotometry



The details of the "spectrophotometer" for quantitative analysis

Secret Radio Communication

SECRET communication by both wireless telephony and telegraphy is made possible through an invention of John Hays Hammond, Jr., of Gloucester, Mass., nationally known in the scientific field. The invention was perfected by 12 years of research work carried on under the direction of Dr. E. Leon Chaffee at Cruft Laboratory, Harvard University. The invention is based on the principle of producing through special transmitting apparatus a type of wave or tone frequency to which only the special receiving apparatus used in connection with the system is receptive.

By the common method of wireless communication, tone frequencies are transmitted in natural form. The new system, by means of vacuum tubes and electric filters, transforms the ordinary tone frequencies into unnatural tone frequencies that can be picked up and converted back to normal only by the special receiving apparatus used with the system. The working of the system may be compared to a conversation between two people in a room in which other persons are shouting. A certain characteristic quality or tone in the voice of the two people in conversation allows them to catch each other's words, even though the noise about them is several times louder than the sound of their voices. In much the same manner, the new system allows two persons to communicate with each other by wireless devices that takes messages of only a certain tone, to the exclusion of the rest. The two parties concerned in a conversation have what may be called a certain mutual "keynote." By using apparatus adjusted to this "keynote" they can converse secretly.

The invention permits the communication of several code messages and telephone conversations over the same apparatus simultaneously. Because outside interference is reduced to a minimum, the new system also allows a greater number of stations to communicate over a given wave length. Furthermore, it permits private broadcasting, as the messages can be caught only by the special receiving apparatus. According to the inventor, the principles carried out in the new invention may be applied to further multiplexing of messages going over telephone wires. Today four or five messages can be sent simultaneously over the same pair of telephone wires. Three times that many are easily possible, the inventor maintains, as a result of the present discoveries.

No changes in transmitting and receiving aerials will be necessary for the use of the new invention, says the inventor. Present receiving apparatus can be adapted to the system, by means of a compact device that is comparatively simple and can be made at a low cost.

Stream Lines for the Motorcycle

DURING the past decade we have learned a lot of things about high speeds which are far from evident, and some of which are quite opposed to common sense. We know, for instance, that far more than half the lifting force on an airplane is derived from the suction on the upper surfaces of the wings, rather than from the actual lifting moment against the lower surfaces. We know, similarly, that an amazing proportion of the atmospheric resistance which any swiftly-moving object has to overcome is due to the vacuum left behind, rather than to the difficulty of parting the air in front. So we pay as much attention, or more, to the proper stream-lining of the rear ends of our projectiles, our airplanes, and our racing cars as to the shape of their prows. And now comes a German inventor, with a stream-line tail for the motorcyclist. Our picture tells the story sufficiently; we need only add the caution that the ingenious device shown is designed for the track and not for the road. Its display before the outraged eyes of the traffic officer would probably be regarded by the magistrate as a confession.

Cutting out the vacuum behind the racing motorcyclist

The Demountable 'Cello

ONE of the most amusing sights of a big city, we think, is the spectacle of the big bass fiddle being escorted to the place of its performance by its proud proprietor, over whom the instrument towers two or three feet when he is standing and correspondingly more when he is seated. Rude remarks about So-and-So and his infant, and rude demands to know where it is taking him, are the order of the day in the presence of this phenomenon. But it looks as though a period might be put to all this ribaldry. Mlle. Adele Clement, a Paris musician, contemplating all the horrors of a trip to Roumania with her 'cello, has invented a collapsible version of this unhandy instrument. That this is really a collapsible affair, and one that can be carried with no more inconvenience than an ordinary violin or horn, is indicated by the right-hand view, showing it demounted for packing. That it is really a musical instrument, in spite of its collapsibility, is sufficiently guaranteed by the fact that one of Paris's leading instrument makers has consented to make it for Mlle. Clement, and further, by the photograph showing the inventor playing it.

The collapsible 'cello, in its playing and its traveling clothes

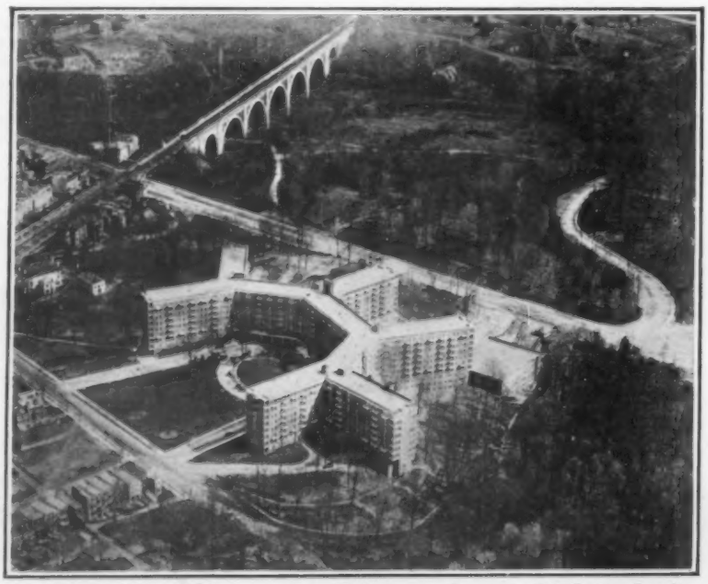
Making Wool Moth-Proof

HOW to prevent moths from feeding on clothes and destroying them has been a problem to which much attention has been paid by textile chemists. In short, the problem has been to find a colorless, odorless chemical, which can be absorbed by wool in small amounts from its aqueous solution, be fixed on the fiber and give it the property of being uneatable by the moth-worm, while not changing in any way the original valuable properties of the wool. It is claimed that this problem has been solved by the well-known German dye concern, Frederick Bayer & Company. After six and one-half years of experimentation of the most careful kind along chemical, dye-technical and zoological lines, they have now introduced on the market a product, called Eulan F, which fulfills all the aforementioned prerequisites.

Various chemicals were examined in regard to their effectiveness in preventing the moth from eating the woolen fiber. The wool, both in the dyed and undyed condition, was dipped in solutions of these chemicals and subjected to the action of moth-worms. The research was commenced with these chemicals which were known to possess a strong physiological action. Almost at the very outset it was found that old Martius yellow afforded a very effective protection against the moth. At the same time the theory that green wool is not attacked by the moth-worm was confirmed. The next step in the problem appeared to be to find a series of dyes which possessed moth-resisting properties, but this was seen to be a very unpromising task, as it was first necessary to find or make such dyestuffs. Then again, when dyed wool was treated with the Martius yellow, it was natural for it to become colored to some degree, and consequently only woolen cloth, dyed in dark shades, could be treated in this manner without spoiling the color. Finally there was also present the desirability of being able to moth-proof white wool.

It was found that the reactions taking place within the digestive tract was predominantly alkaline in character. This was determined by feeding the moth-worm with woolen fiber, impregnated with indicators. Alkaline substances which were found to have an effect on the moth were few in number; for example, benzoin and benzil. Various inorganic chemicals were experimented with. Tungsten salts and titanium compounds were found to be fairly effective, while copper, lead and chromium compounds did not have any effect at all. All the other corrosive metallic salts did not have a strong enough action. It was proved conclusively that alum is not destructive to the moth-worm. The greatest difficulty was encountered in developing a product, which would possess a sufficient poisoning action on the moth-worm, and which would remain fast to the wool.

The product, which was finally developed and given the name of Eulan F, is a white powder, which is soluble with difficulty in water. It is employed in an acid bath in the cold. About a 1 per cent solution is used. The wool is thoroughly impregnated with the solution, then it is spooled after a few hours and finally dried.—*Abstracted by I. Ginsberg from article by Mackbach, Chemiker Zeitung, 1922, 573-4.*



An apartment house of ultra-modern design, seen from a point that makes its lay-out remarkably clear

A Novel View of a Novel Apartment House

WHO does not remember the "railroad flat" of the '90s, with its five or six or even seven rooms, one behind another, lined up along a private hall, and all save the front and the back rooms in Stygian darkness, despite the gas burner always going in the hall? Who does not recall the feeble efforts to get away from this sort of thing which were made by the first builders of "apartments" that grouped several leases on a single floor? And who does not appreciate the contrast between these early examples of the pigeonhole type of domestic accommodations and the wide-open, light and airy modern apartments?

It is obvious to anyone who gives his attention to the matter that the difference is due to the fact that the modern apartment house is not a single solid block. It may be rectangular in outline, but if it is there will be found ample courts cutting in from the sides to relieve this rectangularity and make all the rooms open to the outside atmosphere. But in the very latest examples of apartment house architecture the right-angled effect is being replaced by a definitely winged structure, so that the courts are in large measure replaced by true open spaces.

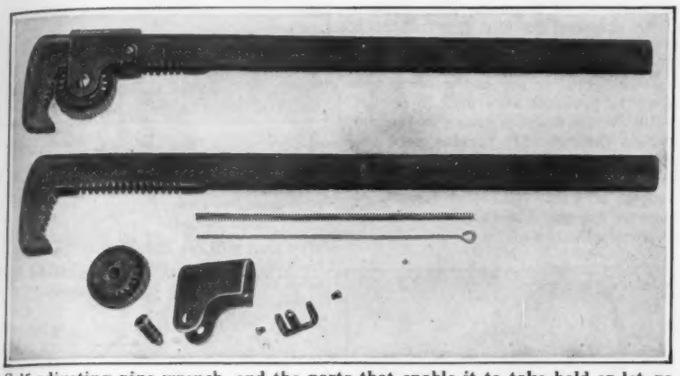
We show herewith a photograph which is remarkable in two respects. Remarkable in the extent to which the builder of this Washington, D. C., apartment house has carried out the open-to-the-air type of construction, and remarkable in the viewpoint of the aerial camera which caught the building from a direction in which all of its straggling structure is visible.

Separation of Palladium and Platinum

IN the investigation of methods for assaying platinum, conducted by the Bureau of Mines, recent experiments have developed that with certain ores, especially when the quantity of platinum is considerable, nitric acid will not effect a separation of platinum and palladium. A method which has been found to be accurate and to result in a complete separation of these metals is described in Serial 2351, "Separation of palladium and platinum by means of dimethylgloxime" obtainable from the Bureau of Mines, Washington, D. C.

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Various Arts and to Patent News



Self-adjusting pipe wrench, and the parts that enable it to take hold or let go with equal facility

The Pipe-Wrench that Never Slips

INSTANT and bull-dog engagement, coupled with instant and hair-trigger disengagement, are the advantages claimed for the pipe-wrench which we illustrate, assembled and taken down to show its parts. The trick lies in the construction of the self-locking, double-geared disk that forms the lower half of the wrench jaws. The wrench is opened by taking hold of the saddle in which this disc rides and pulling it back toward the butt end, the disk rolling smoothly with it. The wrench is then placed so that the pipe falls in the notch in the head, and the disk is released. Under pressure of the spring, the disk then rolls up the rack until it is in contact with the pipe. When the user then presses down on the handle with a slight pull, the wrench will then take hold instantly, the torsional nature of the pressure preventing the disk from rolling back the way it came. The only way to disengage the wrench is to stop pulling down, and to push straight forward—whereupon the disk will promptly roll away from the work.

Protection for the X-Ray Worker

ROENTGEN-ray operators have been martyrs to their profession in more ways than one; and although from time to time protective appliances have been put forward, the danger of this work has been decreased little. A London committee has recently been formed to design a standard protective dress, and the result is illustrated. This curious gear comprises cap and apron of three thicknesses of leather, chemically treated, with a thin sheet of lead between each two of leather. The goggles are of lead-treated talc. The apron weighs eight pounds and the cap two. Gloves of similar construction weigh a pound and a half, and complete the armor which lends the necessary protection against the searching X-rays.

Lead-lined leather garments for the X-ray operator

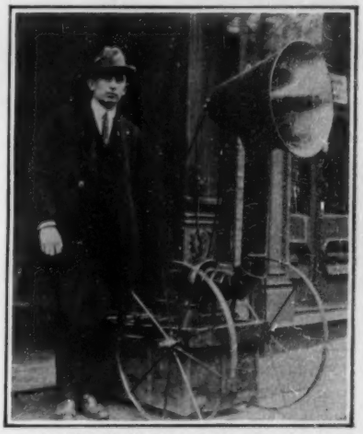
The Mutual Action of Adjacent Photographic Images

REVIEW of previous work shows that the results are so conflicting that general conclusions cannot be drawn. Three factors seem to control the action. The *turbidity effect* causes an attraction through optical reinforcement of adjacent sides of the images. An equation is derived from which the attraction is found to be negligible, except for very small images very close together. The *gelatine effect* causes an attraction due to the more rapid drying of the developed image. It is measured by the difference in the separation of images when wet and when dry. For normal exposures of star images less than 0.1 mm. apart the attraction is equal to about 2μ for ordinary developers excepting pyrometol, while in the case of lines the attraction is about 5μ. This attraction is only slightly changed by varying the amount of sulfite or by the use of a hardener. The *developer or Kostinsky effect* causes a repulsion as a result of the restraining effect of the products of the developing reaction, as in the Eberhard effect. It varies somewhat with the developer, but increases with the exposure. The *variation of the total effect with exposure* is such that overexposed images show strong repulsion due to the large developer effect, whereas normally exposed images show an attraction which usually amounts to 2 or 3μ. To minimize the error which the effect may introduce into measurements of such images the exposure should be as short as possible. The phenomenon is so complicated that it may be impossible to eliminate it completely.

In the case of spectral *absorption lines*, both the gelatine effect and the developer effect cause a repulsion, but in addition to the attraction due to the turbidity effect there is a further attraction due to the difference in the sharpness of outer and inner edges caused by turbidity and halation. In general the total effect is an attraction, about 1μ for normal exposures, but larger for overexposures. Seed 30 plates were used.—*Frank E. Ross*, in *Astro-Physical Journal*.

Fighting Insects with a Bright Light and a Big Wind

THE accompanying illustration might well go under the caption "What is it?" for its nature would surely never be guessed without a clue. It is a bug-catcher invented by James F. Cross of Kenton, Tenn. The bug is lured to his destruction by his fondness for the bright lights. In the big funnel burns a brilliant electric globe; and when Mr. Moth or Mrs. Boll-Weevil comes close enough, on investigation bound, the suction of a powerful electric turbine in the base of the funnel seizes the luckless insect and hurls it down the stove-pipe into the big box below, from which a trap prevents escape. The machine was designed primarily to rid Cross's cotton of the boll-weevil that was threatening to destroy it, but is obviously highly suitable for use against any insect that is attracted by light. The inventor has trapped from ten to fifteen bushels of weevils per night. Apparently the only step that remains to be taken is to devise a way to make something useful out of the catch.



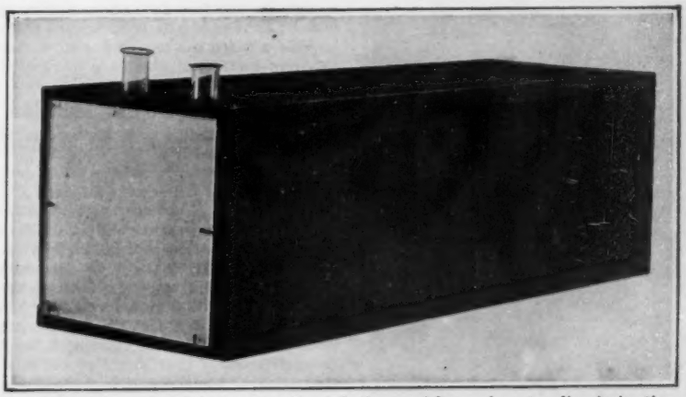
A bright light lures insect pests to destruction, and a turbine fan does the rest

Have You an Eye for Color?

A NOVEL method of selecting the individual best fitted for distinguishing fine differences in color was recently put into effect at the Pittsburgh experiment station of the Bureau of Mines, United States Department of Interior. Reliable methods of analysis are essential in the prevention and treatment of carbon monoxide poisoning among persons working in mines and metal industries, which involve the use of color comparisons. One of these methods lends itself readily to detection of the variation in tints, while the other way is more difficult of determination. The latter, however, is otherwise much simpler. So, a hitherto untried application of this method was authorized, the most sensitive eyes in the scientific laboratory force being thus employed.

Standard tests involving the use of all colors were not employed; only those occurring in the analysis being used. Solutions were prepared of the two hemoglobins, from which twenty-four different pairs were made up and placed in test tubes like those anticipated to be of service in the analysis. One of each pair varied from the other in percentage of carbon monoxide hemoglobin by quantities ranging from two and one-half per cent to twenty per cent. Each pair was compared in a specially-constructed box built by the Bureau of Mines at its Pittsburgh experiment station, as herewith illustrated. It is 20 inches long and 5 inches square in cross section. One end is covered with ground glass; on the inside of this glass covering are two slots, each the width of the test tubes containing the color samples. These tubes are placed into the slots through two openings in the top of the box. Then, the device is placed before a window, away from the sun, and so stationed that there are uniform light conditions on each slit or opening. Here, persons submitting themselves to ascertain whether they are "color blind" or have eyes sensitive to fine color differences seat themselves before the box. The tubes are placed side by side for inspection, and the observer marks whether A (left) or B (right) contains the color of greater cherry pink. The procedure continues until all the pairs of color samples are compared.

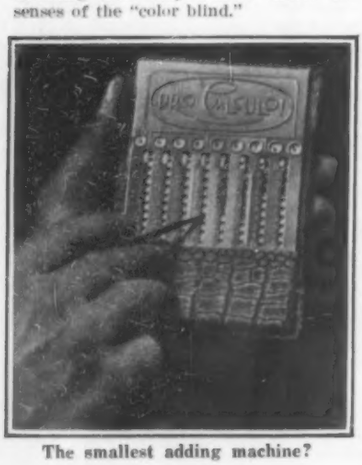
The new method is not only one of



Apparatus for examining test-tube solutions with a view to discriminating between fine variations in shade

Paying for the 'phone as it is used

scientific precision, but is a study in psychology. In fact, this unique way of selecting applicants for color work in chemistry was suggested by Dr. L. L. Thurston, head of the department of psychology at the Carnegie Institute of Technology, Pittsburgh. The procedure is a modified application of the so-called Haldane carmine determination of carbon monoxide in the blood. Chemically speaking, the plain oxyhemoglobin of the blood in dilute solution is a pale straw color, but when exposed to carbon monoxide the color of cherry pink is produced. In chemical analysis, dilute indigo carmine is added to oxyhemoglobin until the solution matches in tint the carbon monoxide hemoglobin. Obviously, the eye most sensitive to faint pink is desired. How to select the person thus qualified was at first a problem; but the suggestion of the psychologist proved a solution. Laboratories throughout the United States, where color work in chemistry is conducted, may examine applicants with success by the application of this method. Twenty-five persons were thus tested by the Carnegie Institute of Technology and the Bureau of Mines, and the results were in harmony with the conclusions of earlier tests as to the correctness of the newly-devised method. Light conditions, containers for samples, and other external factors, influence the success of color determinations in analytical chemistry. The training of the individual in colorimetry, too, is of value, but these factors are of little avail unless the eye is sensitive to fine variations in color. Dazzling hues may fail to excite the senses of the "color blind."



The smallest adding machine?

Cash for the 'Phone Bill

THOSE of us who live in apartments, and have to pay at the end of the month for the telephone calls we have used, are often shocked by the size of the bill when it finally arrives. A means for softening the blow is provided by the telephone bank illustrated herewith. As each call is made, one deposits a nickel in the cylinder. When the month is up, there will be enough cash in the bank to meet the bill—unless some member of the family has been holding out. Incidentally, if one has neighbors who are in the habit of taking advantage of the facilities of the telephone, this might be as good a way as any of indicating that the instrument was not installed for the public benefit.

The Four-In-One Electric Plug

TWO-WAY plugs that enable us to run the lamp and the vacuum cleaner, or the hair-curler and the water-heater, from the single wall-connection or lamp-socket, are familiar enough, and we all appreciate their convenience. Now, however, we may make the one connection with the feed wires serve four purposes at once, by using the clever four-way plug illustrated herewith. The plug has a well-protected feed wire arranged to be plugged into an ordinary lamp-socket; and in addition four places at which connections can be plugged in for outgoing current for lights and other things.

Adding an Ounce of Comfort to the Flat-Iron

THE ordinary flat-iron is probably not the only thing which is gripped by its user with fingers alone, leaving an utterly superfluous thumb to overflow upon the landscape adjoining and find a place for itself as best it can; but it affords one of the most aggravating instances of

A flat-iron that provides a place for the user's thumb

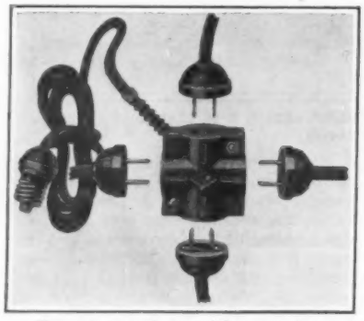
this particular type of digital superfluity. The user of the iron which we show here, however, may iron all day without a thought to the fact that she possesses a thumb; for the handle is so shaped as to provide a place for her to put it, naturally and restfully.

A Vest-Pocket Adding Machine

NOTHING in the way of mechanical novelty features this adding machine. It works just like any other adding machine of the crankless type; to add 324 to what has gone before, one inserts the little operating tool at the 3 in the hundreds column and at the 2 in the tens column and at the 4 in the units column, each time pushing it down to the bottom of the column before removing. The model which we show, however, is notable by virtue of its extremely small size. We doubt that many would take the claim of the above title seriously, if confronted with the bold proposition in the absence of demonstration.

The Ribbon that Re-Inks as it Rolls

WITH this ribbon inking device for typewriters, it is possible to re-ink an old ribbon while it is being run in a normal way through the typewriter, and without any attention to the operation of the inking device. It is not necessary to remove the ribbon from its place in the machine, either to re-ink or to change the character of the ink. The re-inker can be attached to any typewriter by means of a thumbscrew, and does its inking by running the ribbon through inking rolls. In operation the inking device under spring pressure rubs against one of the rolls which distributes ink as the ribbon runs through. By turning back the cover over a little ink fountain, the ink can be replenished. Different colored inks can be used, either for the whole ribbon or for parts thereof, without any added complications.



Four connections with one plug

Detonation in Internal Combustion Engines

FOR several years the Bureau of Standards has been engaged in general investigational work on the performance of internal combustion engines of the types used in aircraft and automobiles. A phase of this work has included a study of the conditions surrounding detonation, and as a result of this work a paper has been prepared for publication by the National Advisory Committee for Aeronautics and it will be shown as Technical Note No. 93 of that committee. The paper, which is entitled "The Background of Detonation," discusses a phase of the question which so far has received but little attention. The effect of the temperature and pressure of the charge before combustion is especially considered, as it is believed that a careful study of this background can throw considerable light on results which have been obtained in the study of detonation, both at the Bureau and elsewhere. Circumstances under which detonation occurs are described and the effects of varying engine conditions are discussed, particular attention being paid to the work of Mr. Henry Ricardo in England, as it is believed that additional facts may be secured from his researches.

It is shown that compression and explosion pressures, scavenging, and the operation of the ignition system all play a prominent part in the phenomenon of detonation. Preignition and detonation are considered to be entirely independent phenomena, and it is shown that overheating troubles are more likely to be caused by preignition than by detonation. The paper includes some curves and diagrams and should prove a valuable contribution to the literature on the internal combustion engine.

Pressure Filtering Through Paper

IN the very nature of things, a filter is clean only until it is put into use the first time. After that, it must necessarily get dirtier and dirtier, until it is finally cleaned. It is most unlikely that

The self-inking attachment for typewriter ribbons

any filter which will continue to function while it is dirty will be cleaned as often as it should. And about the only type that will not function when dirty is the paper filter, familiar to all of us who have ever seen the inside of a chemistry laboratory.

The ordinary laboratory expedient, however, of using a piece of filter paper in a glass funnel is crude enough. Particularly annoying is it to have the paper break near the end of the filtering, as it so often does, being unsupported at the point of greatest strain. But there is no escape from the conclusion that the paper filter is the clean filter par excellence—for when it is dirty it will not filter!

We illustrate an apparatus which is now on the market for filtering practically any liquid, by the paper method. It differs from the laboratory practice in that the filtering is done under pressure, the liquid being siphoned through the instrument. The paper lines the inside of the big flat filtering member, and is supported at all points so that no breakage can take place. The pump is used for only a few strokes, to set up the siphon action; after this the fluid continues to flow automatically.

An interesting feature of this filter is the rapidity with which it works—while the paper is clean, of course. At a recent test, a quantity of iron hydroxide was satisfactorily filtered in an hour, which would have taken a week to filter by other methods. The freedom from evaporation losses attained through this quick operation and by virtue of the fact that the filter is air-tight is an important item. This filter is offered in sizes suitable for household use in connection with the water supply, for factory filtering of perfumes, oils and dyes, for laboratory and drug-store use, etc.

Filter paper inside the circular chamber, and siphon pressure to drive the fluid through it, are the novel features of this filter assembly

The salt shaker that cuts the crust of salt out of the holes

The Shaker that Always Salts

WHEN the knurled knob on the top of this salt shaker is turned, salt will flow freely from the top. It revolves a series of small cutting knives, which in turn cut the crust of salt in the top around the perforations. The holes, which are usually closed in damp weather on the average shaker, are kept opened. The amount of flow from the shaker can be controlled by the same cutting device.

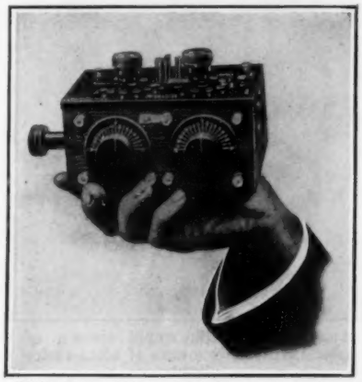
A Complete Radio Receiving Set that Fits in the Hand

THE new "microdion," as a French receiving set is called, in spite of its small size forms a radio outfit which is complete and is intended for exact working. This patented device contains a number of improvements which will be appreciated, and it is attracting quite a little attention in Paris radio circles.

At the front will be seen two control knobs for the two adjustable condensers, one placed in the antenna-ground circuit and the other in parallel on the tuning coil. The tuning and tickler coils are mounted upon a common tube and are formed of nine flat coil sections, each having its contact point. On account of the constantly increasing wave length of the large transmitting stations, it has been found necessary to increase considerably the size of the tuning coils in receiving sets. The size can be reduced in the first place by means of the flat coils, but within a recent period it has been feasible to produce cores made of a very fine soft-iron wire, and these can be used in order to apply the effects of self-induction to radio coils, about as in the usual induction coil, and this will again reduce the size of the flat coils.

The microdion makes use of this improvement, and the wave-length of the coil is increased at will by the introduction of a soft-iron wire core to a greater or less degree, and this gives a most exact tuning and affords the perfect coupling of the tuning coil with the tickler coil. The core which slides through the two coils now transmits the energy not only by the direct action of one wire upon another but especially by the variation of the magnetic field. On the other hand, the wave-length of the tickler coil is increased to a like degree, since the same core extends through both of the coils.

A new type of three-electrode lamp with low current now makes it possible to operate with small batteries of dry cells for the plate circuit as well as for the heating, so that this results in a compact set contained in a small battery box, the connection being made with the microdion by cord and plug. We are obliged to omit a number of other improvements in default of space in which to describe them. It should be noticed that the microdion and battery box can be carried in a 4 x 5-inch camera box.



This tiny radio receiving set makes use of a vacuum-tube detector

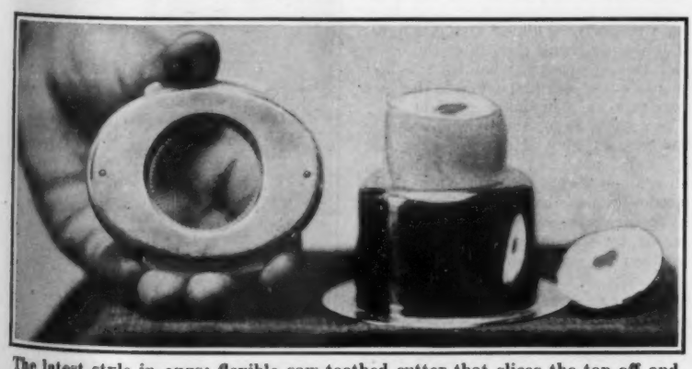
Black Glass and Its Use

BLACK glass, which is of use as an electric insulating material, and which has a small thermal expansion, is made, according to a recent British patent, by melting a natural rock, such as schist, consisting chiefly of quartz, lime and alumina, and adding a further quantity of one or more of these substances until the melt contains about one part aluminum oxide, 1.65 parts calcium oxide, and more than 3.56 parts of silica, the excess of silica beyond 3.56 parts being calculated so that all other oxides present may be converted into silicates. The main ingredient of the finished product has the chemical formula $(SiO_2)_6$, Al_2O_3, $(CaO)_2$ and melts at about 1250 degrees Centigrade.

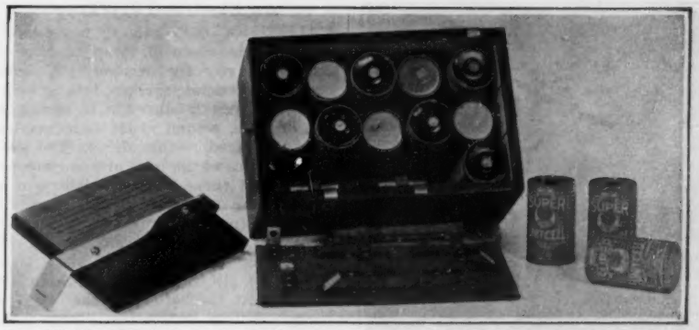
Keeping Eggshells in Their Place

THERE are things which are more dangerous to get in one's mouth than eggshells, but of all the things that ordinary accident carries to our mouths, few are more aggravating than eggshells. Nor is it always easy to manipulate the natural chicken-fruit in such a way as to insure that all the shell shall go into the saucer. But the device pictured herewith takes the whole situation right out of our hands. One simply puts this circular affair about the top of the egg, presses sharply—and the egg is decapitated as nearly as though it were a bit of butter and the tool a sharp knife. The photograph shows the saw-teeth that do the business.

The manufacturer of the device does not indicate its limitations, but we infer that it is designed for hard-boiled eggs only. Its use on the soft variety would seem to be accompanied by considerable hazard!



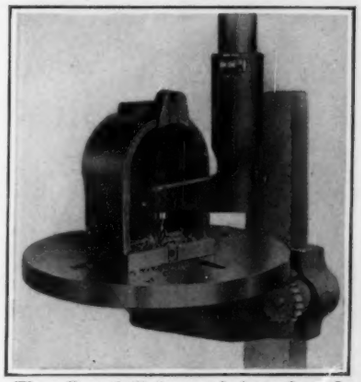
The latest style in eggs; flexible saw-toothed cutter that slices the top off and keeps the meat clear of the shell



A refillable "B" battery for radio receiving sets, making use of the standard unit cells now employed in flashlamps

The Drill for Tight Corners

THIS device is used as an attachment for drill presses in drilling, facing and counterboring holes and bosses in out-of-the-way places that cannot be reached by usual methods. The attachment is so arranged that it may be swiveled around the center of the drill press spindle in any position which is most convenient for the work. The tool holder has a positive drive and a means for holding the tool centrally so that it will run true and the change from one tool to another can be made without disturbing the set-up of the attachment in the press. The tool is driven by a square shaft which gives a strong and powerful drive.



The offset drill for work in awkward places

A Refillable "B" Battery for the Radio Set

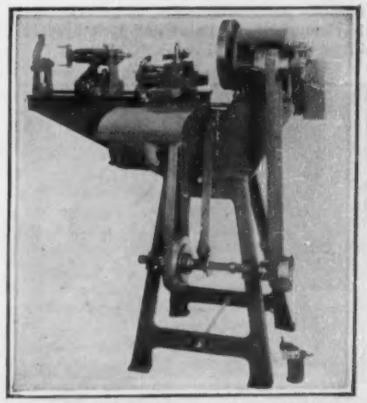
THE usual vacuum tube employed in radio reception requires the use of two batteries for its operation. There is the storage battery, which supplies current for the filament, and there is the "B" or plate battery, which furnishes energy for the plate circuit. The "B" battery should have a voltage of 22½ for detector tubes, and 45 to 100 for amplifier tubes. Generally, a "B" battery comprises a number of small dry cells connected together and encased in a cardboard container, thoroughly sealed in to insure perfect connections and to keep out moisture.

Now the great drawback with the usual type of "B" battery is that all the cells are not necessarily employed. If the battery is being used with a detector tube, only 16 or 18 volts may be required, and two, three or four cells may not be used. Yet after a while the majority of the cells are exhausted, and the unused cells must be discarded along with the dead cells for the reason that they are all cast *en bloc*, to use a good automobile expression.

To obviate this wastage, there has been invented an ingenious container which takes the usual unit cells now employed for flashlamps. As will be noted in the accompanying illustration, the container has square compartments which take the unit cells, while brass springs or strips on the bottom of the container and also on a fiber cover which fits over the cells, make the necessary series connections. A wooden cover, finished off to match the rest of the container, is placed on top of the fiber connection board and is held in place by its nickeled strap which engages with screws at the ends of the case. The cover slides into place without the use of tools. The battery thus assembled is a most efficient one. No solder being employed for connections, there is no danger of imperfect connections or the presence of soldering paste that might cause leaks. Furthermore, the cells are thoroughly insulated one from the other. Hence there are no troublesome noises incurred through the use of this renewable battery.

A Lathe with Novel Features

ONE of the features of a new-model lathe recently put out from Cincinnati is the quick-change feed box provided with a clutch member for engaging and disengaging the feed. The double crank-handle at the right of the gear box is used for reversing the carriage when working on short jobs close to the face



Drive and feed box of this lathe distinguish it from standard models

Electrocution awaits the fly that alights on this snare

plate. The reverse gears for obtaining right- and left-hand threads are contained within the swinging quadrant at the end of the headstock, which houses also the compounding gears for the steel cone-gears within the change-gear box. The cross slide may be swivelled at any angle for angular turning, and when set for straight facing taper dowel pins serve to secure it in its proper location.

The method of driving this lathe is also novel. The countershaft is mounted in self-alining bronze boxes secured to the leg back of the machine; and this countershaft may be driven direct from a line shaft to a friction pulley on the countershaft, or by motor. The half-horsepower motor is secured directly to the back of the bed, and is connected by belt to the friction pulley of the countershaft. When arranged in this manner the entire machine, including its motor, is a single unit and may be moved to any convenient position and connected to a light socket. A portable lathe is thus provided which may be taken directly to the floor on which large machinery is being erected, where it is often useful in making slight alterations.

The Rapid Rust-Scrubber

REVOLVING wire brushes for the removal of old paint and rust have been in use; but their utility is considerably enhanced by the discovery that they last longer when rotated at high speed than when run at lower rates. The brush illustrated herewith operates by compressed air, at a velocity of 4200 revolutions per minute. A steel gondola car is cleaned of old paint and rust by this brush in three and one-half hours.

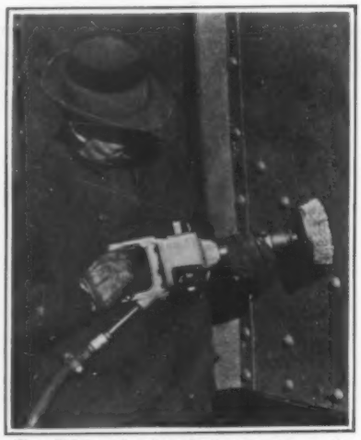
This little device prevents the fingers from sliding down the pencil or penholder

An Electrical Fly-Trap

ELECTROCUTING the fly promises to take the place of swatting him, if the fly-trap recently invented by a clever French electrician spreads into general use. The trap in question is simply a coil of wire, wound about four wooden posts arranged rectangularly. The successive turns of the coil are so close together that there is no possibility of a fly's settling on one without at the same time touching the next one, above or below. This, of course, means a short-circuit; and the voltage is more than enough to kill the toughest *Musca domestica*. At the bottom of the coil is a receptacle into which the corpse falls. This electrical fly-trap has scored a huge success in the French colonies, almost all of which are in tropical climates.

A Self-Cleaning Spark Plug

ONE of the most interesting additions to the list of trouble-eliminators for motorists is a spark-plug of distinctive design which cleans itself and thus relieves the car owner of a long-abhorred task. The new plug obtains its results by means of a thin monelmetal disk which forms a chamber in the base of the plug. The gas taken into this chamber, in contact with the super-heated surfaces, is vaporized to an exceptional degree. When the spark occurs this inner charge of gas is instantaneously exploded and a spurt of flame is sent down into the cylinder, where it insures quick and powerful combustion. The high vaporization of the gas in the plug chamber prevents carbon from forming on the insulator, and the spurt of flame which follows each spark continuously scours the sparking points clean. The new plug, which was originally perfected for aviation service in the Liberty Motor, is now available for automobile motors of all makes. Owing to the intensity



Revolving wire brush for use on rust and old paint

of the ignition it calls for a very lean mixture and is credited with reducing fuel consumption while giving greater power through more efficient combustion.

The Non-Skid Penholder

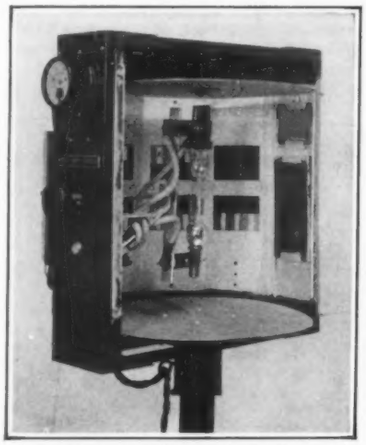
WE illustrate a handy little device invented by M. J. McQuigan of Ashland for use with lead pencils or penholders. By placing this rubber tube having a number of longitudinal slits at a desired position on the pencil the gripping is made much easier and there is eliminated the constant slipping down of the fingers during writing. The soft rubber sleeve is adapted to various sizes of pencils or penholders and the slits may be regulated so that any finger position may be cared for. This is made possible by twisting the solid ends of the rubber sleeve and pushing them toward one another when in place on the pencil.

The Flexible Shoe-Horn

METAL shoe-horns will not conform to the shape of every foot. This one, of leather, is extremely flexible, and fits the foot by conforming perfectly to the heel as it is being pushed into the shoe. In the pocket or the traveling bag it lies flat and takes up no room to speak of.

A Week's Fading in a Minute

THE two greatest chemical agents in existence are water and light. There is probably no substance that is absolutely insoluble in water, and none that is absolutely immune to the action of light. And since chemical change in a

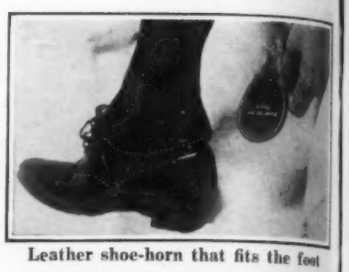


Apparatus for the rapid testing of color-fastness by means of ultra-violet light

substance produces very generally a new substance of a new color, the tendency of all things exposed to light is to fade. It is known now, as it was not until very recently, that the radiations which have no effect upon the eye, and which are commonly known as the ultra-violet, are the most active agents in the process of fading. The sources of artificial light used throughout the ages do not contain the ultra-violet, and hence it has always been the case that delicate colors which would not stand sunlight could be exposed with immunity to lamp-light. But in the electric light we have ultra-violet as well as visible radiations. This of course means that colors fade in electric light as well as in sunlight; but, on the other hand, it gives us a very handy and rapid machinery for testing the durability of colors.

Formerly there was no substitute for the sun in such tests; we could learn how fast a given material of a given color would fade only by exposing it to the sun, and waiting, perhaps, many weeks or months for results. But in view of the fact that it is the ultra-violet rays that mainly cause fading, it is now possible to subject test materials to an intensive bombardment of these rays from a properly regulated artificial light, and to deduce, from the life of the color under this treatment, what its life and rate of fading would be under the less severe attacks of ordinary sunlight.

The apparatus for these tests, recently developed, consists of a lamp contained in a tube some six inches in length, which, along with a brilliant white light, emits an intense flux of ultra-violet rays. The construction of this lamp was made possible by the discovery of ways of working pure silica into tubes and other forms, substantially as glass is worked. Clear silica is one of the few substances that is wholly transparent to ultra-violet rays; hence by using it as the container for the luminescent mercury vapor these are available in an intensity which they can never possess in coming from a glass



Leather shoe-horn that fits the foot

container, with its relative opacity to ultra-violet. It is thus possible to concentrate the fading of weeks and months into hours or even minutes, and to effect a great saving in the time and the expense of color fastness tests.

The Latest Industrial Gas-Mask

PROOF that a special type of oxygen breathing apparatus designed especially for Navy use will furnish practical protection for long periods against dangerous gases is found in the results of recently completed Government tests. It has been shown that the new apparatus can be depended upon to furnish the wearer with untainted air during half an hour of continuous work in gas-laden atmospheres such as often exist in holds of ships when men who have been overcome must be rescued or repair work carried on. The apparatus was devised, at the Navy's request, by George S. McCaa, a mine safety engineer of the Bureau of Mines. Particular need for such an apparatus exists, it is said, in submarines when chlorine gas is given off by the storage batteries or in fighting fires in the hold of a ship. During the working tests, a Bureau of Mines employee remained under water for a half hour, breathing only the oxygen contained in the apparatus.

The oxygen cylinder of the apparatus contains 70 liters of oxygen, under a pressure of 2205 pounds to the square inch. This oxygen is fed to the wearer through a valve which automatically supplies oxygen as it is needed. The complete apparatus weighs seventeen pounds. In the demonstration the apparatus was unpacked from its case, adjusted on the wearer and was ready for use in nineteen seconds.

This mask enables its wearer to work for half an hour in atmospheres laden with noxious gas

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Conducted by ISMAR GINSBERG, Chemical Engineer

Hydrogen with the Aid of Ferrosilicon

IN the Journal of the Franklin Institute, May, 1922, page 656, there is described a method of making hydrogen by the aid of ferrosilicon in a solution of caustic soda. While this process is somewhat more expensive than the other methods of making hydrogen, the gas that is produced is particularly well suited for military purposes on account of the small initial cost of the plant and simplicity of its operation. The temperature of the process must be carefully controlled. None of the materials used is combustible and they do not give off any gas until mixed and are easily transportable. Gas of high purity, containing only traces of phosphine and acetylene, is made in this manner.

Aniline Oil in Internal Combustion Engines

THE combustion of fuel in the cylinders of internal combustion engines always results in the deposition of carbon on the walls of the cylinder. The addition of just a small amount of aniline oil to the engine fuel is claimed both to eliminate the formation of carbon deposits and likewise to increase the efficiency of the machine per unit weight of fuel.

Cellulose from Corn Straw

ACCORDING to a report made to the Hungarian Academy of Sciences, a process has been developed in Hungary for treating corn straw, of which large quantities are available in that country. The Vegyi Ipar process, as it is called, produces 40 pounds of cellulose, 40 pounds of molasses (?) and 5 pounds of artificial fertilizer from every 100 pounds of straw. The considerable value of the by-products represents a decided advantage over the ordinary methods of obtaining cellulose from wood chips.

Newsprint from Mountain Gum

MOUNTAIN gum is found in large quantities in New South Wales, Australia, and up to the present time has been without any technical importance. It is reported that newsprint has been made from this material successfully.

Practical Applications of Electro-Osmosis

MANY applications have been made of electro-osmosis and the electrolysis of colloidal solutions. These are discussed in an interesting article appearing in *Chimie et Industrie*, April, 1922. Leather has been tanned by the aid of electricity. The skins are immersed in a bath of the tanning agent while a current of electricity is passing through the solution. Electro-osmosis takes place; the time of tanning is reduced considerably. Skins have been dyed in a bath, which is electrolyzed. Another application of electro-osmosis is in the dehydration of peat. The current is passed through the watery peat; the peat collects at the positive pole. Clays can be purified by suspending the clay in a solution of oxalate or acetate of soda and passing the current through it. The particles of clay collect at the anode, while the impurities are discharged at the cathode. Clays can also be decolorized by this process. Wood is treated by being immersed first in a bath of soap, and then in a solution of aluminum salt which is electrolyzed. A precipitation of an aluminum soap results. The process of electro-osmosis has also been used to inject various substances into the woody fiber, which will bestow special properties on it. For example, the wood may be impregnated first with a solution of borate of sodium, 10 per cent strength, and then treated in an electrolyzed bath of 5 per cent of resinate of soda. The wood, treated in this bath at a temperature of 35 degrees C., is rendered imputrescible. Furthermore, the resin introduced into the pores of the wood gives it the property of repelling moisture. Electro-osmosis has been used in the process of making paper pulp from various vegetable fibers. It aids considerably in the manufacture of the various derivatives of celluloid, such as viscose, acetate, etc. This electrical treatment of various fruit juices and extracts containing impurities is also of importance.

Industrial Importance of the Garnet

MOST people consider the garnet, the dark red gem stone, as suitable only for making jewelry. The mineral is, however, of considerable industrial importance. Large quantities are consumed in the manufacture of abrasive cloth and paper. Garnet paper or cloth is used in smoothing down hard wood. An ordinary piano requires about 25 square feet of garnet paper in its manufacture. The production and utilization of the garnet are studied and reported in Serial 2347, just issued by the Bureau of Mines.

Vanadium Compounds as Paint Driers

SATISFACTORY driers for linseed oil may be prepared by heating ammonium metavanadate with rosin or linseed oil. The driers that are made in this manner, when used in amounts sufficient to give 0.2 per cent of vanadium in the oil, cause it to dry to a hard, tough, smooth film. Vanadium is superior to lead in drying power, and gives smoother and tougher films than does manganese or cobalt. The principal objection to vanadium driers is that they darken the oil somewhat. For further details see *Journal of Industrial and Engineering Chemistry*, 1922, 14, 222-224.

Soap from Corn-Meal

A NEW soap has appeared on the market, which is made from maize or corn-meal. This soap is made in various forms for use in the home and in textile plants. It is claimed that the soap will remove spots, dirt and all sorts of stains and smudges from the skin and from all the different textile fabrics. The soap is cheap and its action is very rapid and thorough. It lathers well and may be used with hard waters. The soap is made in the United States.

Bleaching Oils

THERE is no general method of bleaching which can be applied to all types of oils. An article in the German journal *Seife* reviews the various processes in common use and gives details about certain bleaching processes which are not so well known. Mention is made of the use of peroxide of benzoyl for bleaching palm oil. The advantages of this process are important, as the bleaching operation does not produce emulsification of the oil and as it is not necessary to filter the oil after it is decolorized. Only from 0.1 to 0.2 per cent of the reagent need be used in bleaching palm oil, for example. The peroxide is dissolved in the oil and the solution is then heated gradually to 100 to 110 degrees C. The oil becomes clear light yellow in color.

Fats from Mineral Oils

MINERAL oils are mixed gradually with filled soap, that is, soap in which the glycerine and lye have been left behind, or with curd soap at temperatures in excess of 180 degrees C. About 5 to 10 per cent of glycerine is also added. The product is a solid fat. The process is patented in Austrian Patent No. 88,000.

White Resin

WHITE resins have been made artificially, according to German Patent No. 351,349. The process consists in reacting on one molecule of a ketone with 6 molecules of formaldehyde, or one of its polymers, such as paraformaldehyde, or a condensation product as hexamethylene tetramine. The reaction is conducted in the presence of an alkali or a salt having an alkaline reaction.

Carbon from Methane

METHANE is decomposed at high temperatures. The carbon is precipitated in various forms. One of these is as hard as glass and forms a most excellent material for making arc light carbons and electrodes for electric furnaces. For further details see the reports of the Hungarian Academy of Sciences.

The Action of Lubricating Oil on Metals

IN an investigation made for the purpose of determining the conditions affecting the selection of the proper oil to use in lubricating various machines in textile plants, the action of the various constituents of the lubricating mixture on the metal lubricated was given particular attention. It was found that cottonseed oil, for example, attacked tin more than any other metal, while rapeseed oil affected copper most, and iron and steel least. Zinc and brass were not acted on in any way by this oil. Olive oil was found to have a very strong action on iron, steel, copper and the alloys containing these metals. Tallow and the oil derived therefrom have a similar effect. Sperm oil attacks tin most strongly and brass least of all. Whale oil, on the other hand, exerts its greatest action on lead, does not attack tin at all. Seal oil acts most strongly on copper, less on brass. Bone oil does not affect steel and iron at all and copper only slightly. Palm oil, palm kernel oil, cocoanut oil and cocoanut fat have an injurious action on steel, iron, copper, zinc, tin and the alloys of these metals. Mineral oils have no injurious action on steel, iron, copper and zinc, attack brass only slightly, but have a marked action on lead. Further details are to be found in the *Textileberichte*, 1922, page 108.

Wood Tar Oil Uses

THE oils that are obtained from the distillation of wood tar can be used as substitutes in the place of various vegetable and mineral oils in much the same manner as the oils obtained from the distillation of coal tar and lignite tar. However, in order to make the wood tar oils available for use in this manner it is necessary to treat them chemically so as to deacidify them and destroy their tendency to oxidize easily. Two processes for accomplishing this are described in *Seife*, 1922, page 633. In both processes the oil fraction, recovered at 250 degrees C, is treated with caustic lime and air is blown through it at the same time until the oil will no longer absorb oxygen from the air. The water is then removed and the oil is distilled, yielding a product which is entirely free from acidity and which will no longer oxidize in the air. It is accordingly available for use as a lubricant.

Plastic Wood

THIS is the name given to a product, just put out on the English market, which is made by colloidal processes. The interesting thing about this product is that it may be used to repair broken or worn wooden articles. A pattern is made of the article and the plastic wood is filled into the mold and allowed to set hard. This takes but a few hours, and the product obtained is said to be extremely hard and possessed of all the characteristics of wood except that it will not absorb moisture like wood does. The hard plastic wood can be worked with the usual carpenter tools, and nails, screws, etc., can be driven into it without fear of the wood splitting.—From *Chemical Age*, London, June 10, 1922.

New Tanning Process

TANNING leather is a time-consuming operation. A process, which is claimed to reduce the time of the tanning to six days, is described in the *Chemical Age* of London, June 3, 1922. This process employs a vacuum, that is, the leather is tanned in a vessel from which the air is exhausted. The tanning agent is treated so as to remove from it all the oxygen that it may contain. Under the vacuum and without oxygen the tanning agent boils or is agitated rapidly like boiling water. Under this condition the hides absorb the tanning liquor quickly. The pores of the hides are wide open as a result of the vacuum, and the tanning liquor penetrates easily, spreads through the mass at once and performs its function quickly with no more damage to the material than under the slow process used heretofore.

Lubricants from Coal Tar

FOLLOWING up their successes in utilizing coal tar for the production of lubricating oil, the Germans have turned their attention to the problem of obtaining similar products from lignite tar. The large deposits of lignite in this country will sooner or later be worked industrially for the many valuable products that can be obtained therefrom by destructive distillation, and the investigations that are being conducted along the above lines are therefore of considerable interest. The results that have been obtained so far are told in *Brennstoffe Chemie*, 1922, page 10.

A-6445, built in less than 21 days at the Naval Aircraft Factory, as she looked when first inflated in the shops

A Record in Balloon Construction

NAVAL experts have not made public detailed results of the balloon race in which the Navy entered two lighter-than-air ships. But the record made in construction of the "A-6445" in three weeks of work at the Naval Aircraft Factory is a good augury of what America can do in event of necessity. This balloon was more or less of an eleventh-hour entry. It was designed and constructed under the direction of Captain G. C. Westervelt, U. S. N., in a little less than ten days, and is the first of its kind to be built by Navy personnel. It is of a new design that if proved workable in further tests is expected to save the Government $100,000 in the construction of each dirigible. The parachute, catenary-type suspension is used, with 56 suspension cords of silk, each capable of holding 250 pounds. The bag is 52½ feet in diameter, with a capacity of 80,000 cubic feet, and the balloon was designed to carry a weight of 3500 pounds.

On its flight the "A-6445" carried a gasoline cook stove, something never before attempted. That was possible because helium gas was used. The fabric of which the bag was made weighs two and a half ounces to the square yard, and the outside was varnished with a special preparation to prevent leakage of the helium gas.

A Stone That Tells a Story

ONE need not be a geologist to take an interest in a piece of rock, known as the "Sunday Stone." It was formed by deposits of white, calcareous mud, alternating with layers of fine coal dust, in a coal-mine at South Shields, and was taken from an open water trough.

When no work was done on Sundays the layers deposited were white, and show up as comparatively broad white bands, each representing a period of time from Saturday to Monday morning, when no work was being done. Between these broad white bands are narrow white and black bands alternating, each black band caused by coal dust mixing with the cacareous matter during the working hours of the day, and each white band representing the night when no work was proceeding. There are six black bands between each of the broader white bands, representing the six working days of the week. Thus, unknown to the unsuspecting miners, this stone silently recorded their periods of work, weeks with holidays in them being represented by fewer black bands.

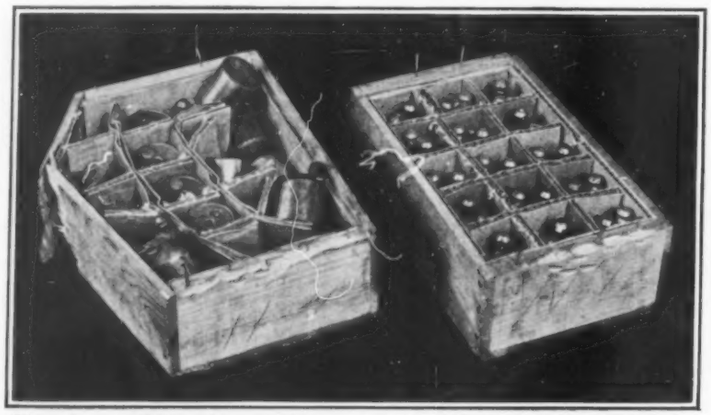
This stone is of great instructive interest, for it indicates, on a small scale, the manner in which the sedimentary, stratified rocks of the earth's crust were deposited by water during the past ages, before they were lowered to vast depths or elevated to mountainous heights by the crumpling of the crust as the world's internal heat escaped and it contracted.

Rum as a Taxi Fuel

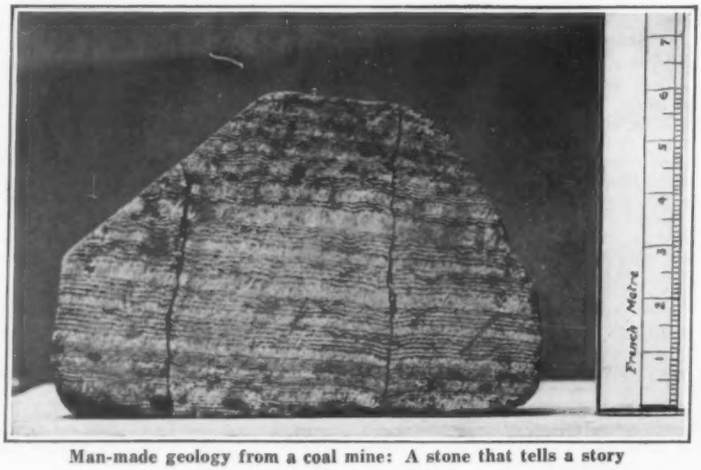
REPORT has it that the taxicabs of Havana are running on what our forefathers knew as rum—though of the denatured variety. They are using it because it is 30 per cent cheaper than gasoline, and it is the product of blackstrap molasses, which is just now a drug on the market. This byproduct of cane-sugar is overflowing the storage tanks; by turning it into automobile fuel, taxi rates have been cut, the minimum now being 20 cents. This cut is said to have been authorized by the mayor at the request of the cabmen themselves, who hope by this means to popularize this mode of travel. The superabundance of blackstrap molasses has given them their opportunity, and everybody and his wife are riding in state. Jamaica, too, is planning an installation near Kingston for the conversion of rum into industrial alcohol. The first consignment to be treated would be one of 800,000 gallons, the spirits being shipped to Canada and elsewhere.

A Packing-Box Demonstration

INTERESTING tests of one sort or another are always being conducted at the Forest Products Laboratory in Madison, Wis. The accompanying photograph shows the results of one of these, of recent date. The subject of proper packing was undergoing one of its periodic examinations, the particular aspect of the matter under investigation at the moment being the effect upon the outer package of looseness of the contents. Two wooden cases containing each fifteen tin cans were put up in identical shape, save that in one the cans were properly packed in their compartments to prevent their motion, while in the other they were left free to rattle about in their little cubby-holes as much as they would. The two boxes were "shipped" the same "distance" in the box-tumbling drum, and the result was as pictured. In spite of the fact that the wooden boxes were identical, the one that held its contents loosely was practically destroyed, while the other showed no ill effects of its "journey." The advantages of having hard objects like cans and jars carefully packed in their cells to prevent shifting was never better illustrated than by this photograph.



These boxes, which underwent the same treatment, were identical save that in the left-hand one the cans were not packed tightly in their cells



Man-made geology from a coal mine: A stone that tells a story

The deaf man's walking stick, showing (right) cross section of the entire instrument, an outline of the stick with its "ear," and the manner of use

Hearing Through a Walking Stick

THERE are many varieties of walking sticks, from the simple wooden rod to the elaborate sword cane. Recently a new cane has been invented which has both an ornamental and a practical scientific value. This walking stick is a device to aid deaf people in hearing. It is a fully-equipped telephone system, complete with switches, tuning coils, batteries and other instruments. But so dexterously have the various parts been made and fitted together that the instrument looks almost exactly like a highly-polished mahogany cane. The inventor has avoided making the usual unsightly type of apparatus that we have been accustomed to associate with the instruments to aid defective hearing. There are no wires, no head-piece, no batteries to be carried in the pocket.

In appearance the "amplion," as it is called, is an ordinary walking stick with a rounded knob handle and a silver neck-band. Instead of being of solid wood, it is a hollow aluminum tube, in the neck and head of which are all the electrical and mechanical devices for the work the cane has to do.

The knob of the cane is virtually a highly-sensitized telephone receiver, consisting of a powerful magnet, the proper coil windings and a delicate diaphragm. One side of the knob is flat and perforated. This is placed against the ear when sitting in the theater or talking to a friend in the street.

Directly behind the receiving apparatus is the tuning coil, which is controlled from without by a small silver screw on the rounded side of the knob. By turning this screw to the right or to the left just a fraction of an inch the instrument may be adjusted to the hearing capacity of any person. Incoming sounds are greatly magnified when the screw is turned completely to the right, and are only slightly intensified when it is moved to the left. In the receiving unit there is also a miniature switch, controlled from without, which serves to connect and to disconnect the batteries. This permits the saving of power when the amplion is not actually in use.

The receiving unit may be separated from the cane proper by unscrewing the knob at the silver neckband. This neck-band is the junction between knob and cane, and separating them in no way disturbs any piece of apparatus in the instrument. The unscrewing requires no more skill than does the simple operation of taking out a flashlight battery when a new dry cell is to be inserted. In fact, the cane operation is the easier of the two, as the amplion neckband is machined on the inside to within one-half of one thousandth of an inch. This carefully made thread also prevents the possible crossing of the thread in screwing the knob into position when these parts are joined together again.

The neck of the cane is a hollow repository for three flashlight battery cells.

The Motor-Driven Commercial Vehicle

Conducted by MAJOR VICTOR W. PAGE, M. S. A. E.

This department is devoted to the interests of present and prospective owners of motor trucks and delivery wagons. The editor will endeavor to answer any question relating to mechanical features, operation and management of commercial motor vehicles

Reducing Truck-Delivery Costs

A CALIFORNIAN motor truck manufacturer has recently introduced a novel method of delivering his motor trucks. The three trucks shown in the accompanying illustration would normally constitute a car load. By arranging these motor trucks so that the front end of the second truck rests on the rear of the first, and the front end of the third truck rests on the rear of the second, it becomes possible for the first truck to haul the other two as trailers, without steering difficulties. The three trucks have been driven from the factory at Oakland to the distributor at Los Angeles, a distance of almost 500 miles, by one man, at a cost of only $40.00 as against a cost of $175.00 if shipped by freight, and with a saving of at least three days in time.

Novel method of delivering a carload of motor trucks. These trucks were driven almost 500 miles by one man at a cost one-quarter that by freight

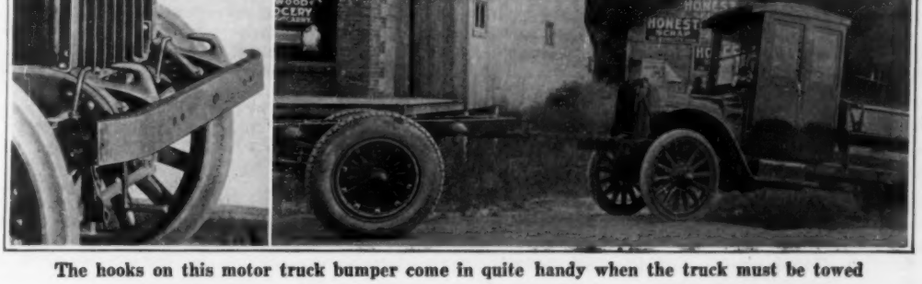
A Safe Motor Truck Hoist

A NEW hydraulic motor truck hoist is mounted on the chassis frame in front of the rear axle about in line with the front hanger of rear spring shackle. It consists of a vertical cylinder or cylinders, depending upon the make of the truck, containing pistons driven by a gear pump. The power to drive the pump is taken from the front propeller shaft or from the amidship transmission and is applied by operating a lever in the driver's seat. The hoist is swung from saddles so that it can give direct lift at all times on the body. The oil is driven by the pump from the upper part of the cylinders through oil ways to the bottom of the cylinders, thus forcing the pistons up. The hoist automatically stops when it reaches its full stroke. To lower the hoist a valve operated from the driver's seat is opened which allows the oil to by-pass back into the head of the cylinder. As the pistons stand on a solid head of oil, which oil must be displaced by passing through this valve, the body can come down at only one rate of speed, thus making it possible for one to work around or under a body equipped with a hoist and be perfectly safe.

The hoist mechanism on this motor truck has several features which make for efficiency and absolute safety

A Truck Bumper Used for Towing

A MANUFACTURER of automobile accessories has recently developed a combination bumper and towing device which will be particularly useful in towing trucks up steep grades when heavily loaded, or towing machines with engine trouble when locomotion is impossible. The towing capacity of the bumper is attained by a hook which is fastened on to the bumper and in turn serves as a support for the bumper in its attachment to the horn of the truck frame. No holes are drilled in the truck frame in fastening the bumper as it is held rigidly in place by two "U" bolts.



The hooks on this motor truck bumper come in quite handy when the truck must be towed

Large Market for Garden Tractors

TO complete the motorization of the farm, the small tractor has been evolved to replace single horse- and hand-operated implements in the preparation of the soil and in planting and cultivating row crops. The small tractor is the newest important development in motorized farm equipment, says a writer in *Automotive Industries*. The potential market for the small tractor is seemingly unlimited in that it can be used on every farm, irrespective of size, down to the small garden patch.

There are over 6,500,000 farms in the United States. About 2,673,000 of them are of approximately 100 acres and nearly 1,000,000 are of less than 20 acres. More than one-half of the total area devoted to all crops is devoted to crops requiring cultivation. The peak load in hours of horse labor on the average farm comes during the cultivation period and not in plowing and fitting the soil, which is work that the present type of large tractor is designed to do. Large farms devoted to general farming have, in addition to row crops, vegetable gardens and large lawns. Thousands of acres are devoted to specialized farming like that of cotton in the South, onions in the Mississippi Valley, beets in the Middle West and West, and tobacco in the Middle Eastern States.

The market gardener near the cities needs the small tractor to complete the motorization of his farm since he uses a motor truck, instead of horses, to carry his produce to the city markets. Usually, he does not grow his horse feed but purchases it. With motor trucks and good roads, the market gardener is not forced to locate near his market on high-priced land, but can locate at a distance where land values are lower. Larger acreage can be purchased, which, through the use of motorized equipment, will give greater returns on the investment. Florists and nurserymen operate under conditions similar to that of the market gardener, and they have been quick to realize the advantages of the small tractor.

Specialized farming and market gardening require considerably less investment and are much more profitable than general farming. Intensive farming will come about as a natural sequence to an increasing population. If the relative increase in population of city over country continues at the same rate as during the past decade—and there is every reason to believe that it will—those remaining on the farm must increase their production of foodstuffs by the greater use of improved power farming machinery.

Markets for the garden tractor in addition to that of the farms are the innumerable greens such as golf courses, parks, cemeteries and large estates where a power lawn mower can be used, since a power lawn mower can be easily attached to the small tractor. There are millions of homes with a lawn and garden patch where the small tractor will lighten the menial task of pushing the lawn mower and the garden cultivator.

The Concrete Road Abroad

THERE has been organized in Great Britain a "Concrete Utilities Bureau," which is now engaged in promoting the cause of the concrete road, both by magazine advertising and by such other means as appear available. The advantages of concrete roads from the viewpoints of gasoline economy, safety, driving comfort and maintenance cost are being put forward very cleverly and very soundly; and in view of the fact that Britain has a very considerable road mileage that is near the breaking-down point, the campaign seems a timely one.

New Steel Felloe Wood Wheel

A NEW design of motor truck wheel which weighs materially less than the conventional wood wheel is now being manufactured and has been adopted as standard equipment by one prominent truck manufacturer. The wood spokes are retained but no wood felloe is used. The inverted channel section takes the place of an S. A. E. band as well as that of the wood felloe. The manufacturers claim that the spoke has a complete bearing of the end grain on metal. The weakest point of the wood wheel, the seating of the spoke shoulder in the felloe, is done away with. It was at this point that practically all failures of wood wheels originated. By retaining the wood spokes, the manufacturers assert, they maintain the shock absorbing possibilities of wood and the new construction adds strength due to the feature described. The new wheel weighs from 25 to 30 per cent less than the regular wood wheel.

The Heavens in October, 1922

Latest Light on the Eternal Problem of the Origin of the Solar System

By Professor Henry Norris Russell, Ph.D.

ONE of the troubles (which indeed are not many or serious) of the astronomer who seeks to answer the questions put to him by the intelligent general public is that, so often, the problems of greatest interest are just those which are hardest to solve. The ever-increasing inquiries regarding the habitability of other planets may serve as one example; another is afforded by the origin of the solar system.

In the latter case we can really say more than in the former. The old nebular hypothesis of La Place, after holding the field for nearly three generations, has been practically supplanted, during the last two decades, by the opinion that the planets were probably produced by a catastrophe—the eruption of vast masses of matter from the sun, under the action of the tidal forces produced by the close approach of some other star. This idea, first launched as the "planetesimal theory" of Chamberlin and Moulton of Chicago, has recently been modified by English astronomers, including Jeans and Jeffreys, and is now often called the "tidal theory." Under whatever name it goes, it accounts as nothing had done previously for the great general outlines of the solar system—the existence of many planets, all revolving in the same direction, and nearly in one plane, very small compared with the sun yet carrying with them almost all of the rotational momentum of the system. There are even some indications regarding the date of the catastrophe, which appears to have taken place a few billion years ago.

Yet there remain serious difficulties. Probably the worst of these has to do with the satellite systems—especially those of Jupiter and Saturn. These might almost be described as solar systems in miniature, and one might expect that their origin might be explained in the same way as that of the main system. But so far, no one has succeeded in showing in detail how this might have happened.

Then the case of the earth and moon stands out as unique, because the two bodies are so much more nearly equal in size than any other primary and its satellite. It looks here as though they had been formed by the breaking up of a single mass; and we know that, if this had happened, the tidal forces would gradually drive the moon to her present considerable distance. But the way in which such a disruption might have happened is still rather obscure.

Still a different problem is presented by the asteroids. Here is a great group of little planets—almost a thousand already catalogued, and doubtless hundreds more to be discovered. Their orbits form an intricate tangle, so that, if they were material wires, one could not pick one of them up without dragging with it almost all the rest. A few of the innermost of the group come inside the orbit of Mars. The remotest are as far away as Jupiter—and at such a distance we can see only the larger ones, so that the outer limits of the group may be even more remote.

How did this huge swarm originate? On the planetesimal theory, the answer is easy enough; they represent the smaller masses thrown out by the great catastrophe, and not "picked up" by collision with any of the larger planets. But why should these small bodies be so numerous outside the orbit of Mars, and so rare nearer the sun? Have they all existed as separate objects for billions of years, or have the present small bodies been formed by the breaking up of fewer and larger ones?

Planetary Explosions and Their Traces

This last question might seem hopeless to answer; but such is not the case. Suppose that, for any reason, a planet should burst or break into pieces, which were then thrown apart at speeds sufficient to carry them away from the influence of their mutual attraction. Each piece would then behave like a separate planet, following its own independent orbit; but all these orbits would pass through the point at which the "explosion" occurred, and thus betray the common origin. This idea is more than a century old, and was suggested by Olbers in 1802 when only two asteroids had been discovered. The orbits of these two, though not actually intersecting, came pretty near one another. But when more asteroids were found, it appeared that their orbits did not pass anywhere near the point of close approach of the other two.

This was, however, not so fatal an objection to the theory as might be supposed. Under the attraction of Jupiter and the other planets, the orbits of the asteroids are continually, though slowly, altering their positions. For a hundred years after the disruption, all the orbits would pass near the point at which it happened; but in the course of ages these slow "secular" changes would shift them, in different ways, until all trace of the original intersection was lost. Some indications might perhaps last for ten thousand years; but a hundred thousand should suffice to wipe out every vestige. We need not therefore be surprised that no such points of intersection are found; it would be very remarkable if, in this old, old system of ours, such an event had occurred so recently.

To penetrate into the obscurity of the more distant past is not so easy, but an important step was made by Newcomb, who showed that no single explosion could possibly account for the tangle of existing orbits. Though the shape and position of each orbit may be changed greatly by the perturbation due to Jupiter's attraction, the size of the orbit varies little if at all. Taking advantage of this Newcomb proved that the smaller orbits are so very much smaller than the larger ones that, no matter how both might be turned about, there was no possibility of their intersecting one another. Hence, if the explosion theory was maintained, it would be necessary to assume that several successive disruptions had occurred, some of the original fragments giving rise, by subsequent dismemberment, to asteroids with small orbits, and others to those with large orbits.

Groups of Asteroids

This idea, which was suggested by Young many years ago, has been recently confirmed in a very striking fashion by the Japanese astronomer Hirayama. It is clear that the more violent the "explosion," the more difficult will it be to trace its results—for in such a case the orbits of the separated fragments will be very different. But if the velocity of separation is small, compared with the orbital motion of the original mass, the orbits of the fragments will be very similar. They will all have nearly the same period, nearly the same eccentricity, nearly the same inclination; and, for many years, the fragments will circle about the sun in a swarm fairly close together. In a few centuries, however, the faster moving ones will string ahead of the slower, till they gain a whole lap on them, like runners in a long race, so that the second stage will show a set of asteroids scattered around the original orbit, or near it, in a sort of ring.

Further complications will ensue as the perturbations get in their work. The planes of the orbits will shift, some faster than others; their eccentricities will change; and the orbits will become more and more unlike. But certain features of similarity will remain. In the first place, the periods of revolution are not perceptibly altered by perturbations and will remain very much alike. Secondly, the perturbations will not, in the long run, produce any material change in the inclination of an asteroid's orbit to that of Jupiter—though the intersection of the two orbit planes, the node, will shift indefinitely. Hence the orbits of the members of each group, which were at the start inclined almost equally to Jupiter's orbit, will remain inclined at the same angle, though in different directions. The possibility which the latter remark brings up makes it plain why we can say only that the inclination to Jupiter's orbit remains substantially fixed, and not that to the ecliptic or to any other plane in the system.

Finally, the changes in the eccentricity of the orbits follow definite laws—though not particularly simple ones. Each orbit has the sun at one focus, while the center of the orbit is at a distance from the sun which depends on the eccentricity. Under the influence of Jupiter, the center of the asteroid's orbit shifts, in space, changing its distance from the sun, but keeping always at substantially the same distance from a fixed point intermediate between the sun and the center of Jupiter's orbit. Just after the "explosion" the centers of the orbits of all the fragments were close together, and at about the same distance from this fixed point. As time passes they will retain this distance, though their directions from the fixed point will vary widely; but they will all lie approximately upon a circle having this point as center.

We have three different and independent tests by which the members of a "family" formed by the disruption of a single body, by a not-too-violent disturbance, can be identified, even after the lapse of ages. Applying these principles, Hirayama has discovered four large groups of asteroids, averaging fifteen members each, and some smaller ones, which satisfy all the conditions described—the periods of all the members of a group being nearly the same, their orbits having substantially the same inclination to Jupiter's orbit, and the centers of their orbits lying very closely on a circle about the fixed point mentioned above. There is not one chance in a million that such a combination of characters as is shown by any one of these groups can be due to chance. The possibility of the grouping of all four of the larger groups by chance is one in a million raised to the fourth power—that is to say, this possibility is utterly beyond belief, without saying a word about Hirayama's smaller groups. It appears therefore to be extremely probable that in several cases a considerable number of asteroids have been formed by the disruption of a single body. What the nature of the disruptive forces may have been remains unknown, and it is not yet determined whether "explosions" of a more violent sort, leaving results harder to trace, have occurred.

The schedule of the planets appears on a later page.

At 11 o'clock: Oct. 7.
At 10½ o'clock: Oct. 14.
At 10 o'clock: Oct. 22.

At 9½ o'clock: October 30.

At 9 o'clock: Nov. 7.
At 8½ o'clock: Nov. 16.
At 8 o'clock: Nov. 23.

The hours given are in Standard Time.

NIGHT SKY: OCTOBER AND NOVEMBER

Recently Patented Inventions

Brief Descriptions of Newly Invented Mechanical and Electrical Devices, Tools, Farm Implements, Etc.

Pertaining to Aeronautics

AERIAL BOMB.—T. J. CAHILL, 238 N. 12th Street, Philadelphia, Pa. The invention relates to bombs for aeronautical use. The prime object is to provide a bomb of the character described housing a plurality of small arm projectiles which are adapted to be simultaneously discharged by the impact of suitable detonator upon its contact with the ground. Particular attention has been directed to the lightness of structure.

AIRPLANE PROPELLER.—A MARTEL, JR., Tonopah, Nevada. The purpose of the invention is to provide a propeller having mechanism which is operable to effect the successive feathering of the propeller blades to simultaneously secure a lifting and propelling action, and which is manually controllable to increase or decrease both the lifting and propelling action to discontinue the feathering action so that only a propelling force is obtained, and to increase or decrease the propelling action.

FIRE EXTINGUISHER FOR AIRPLANES.—W. J. SANKEY, JR., Hatchechubbee, Ala. This invention relates to airplanes, dirigible balloons and the like, and has particular reference to the fuselage thereof, the purpose being to provide a fuselage having means for extinguishing any and all conflagrations occurring in the engine and fuel compartments during flight and thereby preventing the usual disastrous results and permitting of safe landing.

AIRPLANE.—W. L. DENHAM, 1615 So. 12th St., Birmingham, Ala. This invention has for its object to provide a machine having planes mounted for rotation in a horizontal plane about a point fixed with respect to the fuselage of the machine, in order to exert a direct lifting force, to enable the machine to climb or descend upon an even keel without tilting, as required in the present type of machine.

AIRPLANE BRAKING DEVICE.—J. B. ANDERSON, c/o Gen. Del., San Francisco, Calif. The invention relates to means for slowing the speed of an airplane, and has reference more particularly to an airplane having auxiliary propellers which are adapted to be rotated in a direction reverse to the direction of the main propeller so that the speed will be decreased when landing, and may also be used to obtain a quick "get-a-way" when rising from the ground.

Pertaining to Apparel

HAT.—H. N. NEPPELL, 202 W. 88th St., New York, N. Y. The invention relates to a foldable outing hat, especially designed for use in ball parks, race tracks, or similar places of amusement. The primary object is to provide a hat which may be sold at a minimum price, or distributed as a medium of advertising. Another object is to provide a hat capable of fitting almost any size or shape of head, and which will effectively shade the face and head of the wearer, and will be cool when in use.

HOOK AND EYE.—MATTIE D. FORREST, Sebastian, Fla. An object of the invention is to provide a hook and eye which may be quickly attached to adjacent edges of a garment and which are self-fastening, in that it is not necessary to sew them to the goods. A further object is to provide a hook and eye formed of spring wire and provided with pins for securing and locking them in a fabric in such manner that there would be no danger of pricking the fingers upon operating the hook and eye.

MITTEN.—M. J. HOLLENBECK, 29 Orchard St., Gloversville, N. Y. The invention relates to mittens made of one piece of material. The object is to provide a mitten arranged to insure a proper fit on the hand, and particularly at the wrist. Another object is to allow the desired movement of the thumb without danger of straining the thumb seam, and to render the mitten seamless at the outer edge, thus avoiding tearing at the outer side.

CORSET CLASP.—GRACE E. MCNAMARA, 6156 Champlain Ave., Chicago, Ill. An object of this invention is to provide a corset clasp in which the fastening members are covered by the body portion of the corset, in which there are no inside or outside projecting members, thus obviating chafing or pinching on the inside of the corset, or the liability of tearing or wearing the clothing on the outside. A further object is to provide a fastening device which will permit the corset to be readily clasped or unclasped.

GARTER.—E. O. HAMMERBERG, 3519 N. Seeley Ave., Chicago, Ill. Among the objects of this invention is to provide a garter suitable for properly holding up a man's sock without making use of an encircling band which might restrict circulation. A further object is to provide a garter that may be quickly and easily attached and adjusted, which is simple in construction and may be quickly and inexpensively produced.

METHOD OF MAKING STOCKINGS.—S. B. RAINS, 785 Myrtle Ave., Brooklyn, N. Y. The invention pertains more particularly to a method of cutting stockings from a blank of fabric material. One of the objects is to provide a method of cutting which eliminates certain operations in forming stockings, as at present constructed. The blank being so formed that the seam falls on the bottom of the foot and on the back of the leg portion, and reinforcing elements are secured to the heel and toe section.

BLOOMER DRESS.—M. KLEIN, 231 Daniel Low Terrace, Tompkinsville, S. I., N. Y. The invention relates to wearing apparel especially adapted for use by little girls and children, and has reference more particularly to a combination dress and bloomers. An object is to provide a combination which gives perfect freedom, which is of simple construction, easy to launder, and requires practically half of the material usually used.

Chemical Processes

PROCESS FOR PRESERVING IN THE FRESH CONDITION ORGANIC MATTERS AND PARTICULARLY MEAT AND FISH.—L. A. C. CHOLET, 5 Rue Michelet, Montreuil-sons-Bois, Seine, France. This process consists in subjecting the substance to be preserved to the simultaneous action of sharp cold, but not freezing the substance, and a volatile antiseptic, and then subjecting the substance to the simultaneous action of intense heat of short duration, sufficient time for reheating the surface only, gradually decreasing the heat, and a violent current of sterilized air.

PROCESS OF PRODUCING CYANIDES.—F. VON BICHOWSKY and J. HARTHAN, Glendale, Calif. The following will serve to illustrate the nature of the invention. As an example: Melt together for 30 minutes at a temperature of about 950 degrees Centigrade a mixture of equal parts of finely ground titanium nitride containing mass and dry sodium formate. The reaction can be represented by the equation:

$$Ti_2\ N_2 + 2Na\ COOH + Fe_2\ C = Ti_2\ O_3 + 2Na\ CN + 3Fe + CO + H_2$$

CHLORINE DERIVATIVES OF HEXAMETHYLENTETRAMINE.—R. BURATTI, Croce Mosso, Italy. This invention refers to the fabrication of organic compounds obtained by the combination of ammonia, ammonium salts and formaldehyde, with the hypochlorites of the alkaline and alkaline-earth metals.

PROCESS FOR REFINING CRUDE CARBON.—C. F. C. HERTING, 2641 Mathews St., Berkeley, Calif. The process of refining crude lamp black consists of boiling the same in an alkaline liquid, heating the product with sulfuric acid until it changes into a thick paste, pouring the latter slowly into boiling water and thereafter adding it to a saline solution.

VAPORIZER FOR LIQUEFIED GASES.—E. S. ANDREWS, 22 Manor Way, Beckenham, England. The invention relates to vaporizers for gases which are in gaseous form at normal temperature and pressure, but which are capable of being stored in liquefied form at low temperatures. The object is to provide a vaporizer fitting for such liquefied gas containers by means of which gas at ordinary temperature can be drawn off at regulated quantity of flow.

Electrical Devices

BATTERY.—D. ROSEN, 545 W. 144th St., New York, N. Y. The invention particularly refers to a dry battery. An object being to provide means whereby the solid and liquid materials entering into the electrolytic action of the battery can be simply and efficiently kept apart until such time as it is desired to put the battery into use, when by the manipulation of a single element the liquid is positively driven into association with the solid material resulting in electrolytic action.

ELECTRICAL DOOR-OPERATING DEVICE.—J. R. KAISERMAN, Livingston, Mont. This invention relates to a door-operating mechanism comprising a motor, a motor-operated clutch adapted to connect the motor with the gearing when the motor is started, and braking means cooperating with clutch to limit the speed of the motor, said clutch being adapted to automatically disconnect the motor from the gearing when the motor is at rest.

SNAP SWITCH.—L. LARSEN, 2311 N. Kedvale Ave., Chicago, Ill. An object is to provide a snap switch for closing electric circuits, in which an oscillating switch arm, when moved in one direction, will operate to break the circuit, and when moved in the opposite direction, will close it, both the opening and closing being accomplished quickly by the action of one spring. When operated the device is positively locked in position until the switch arm is moved.

ELECTRICALLY CONTROLLED HEATER.—C. E. PATTERSON, 514 S. Figueroa St., Los Angeles, Calif. This invention has for its object to provide a heater wherein the heating element is so supported and mounted that the radiated heat rays may be reflected either directly forward, or in the form of a cone, and wherein means is provided in connection with the support for insuring a free and unrestricted flow of air about the heater.

IMPLEMENT FOR REMOVING SEPARATORS FROM STORAGE BATTERIES.—E. A. FOETISCH, 405 W. Cooper Ave., Albuquerque, N. M. The invention relates generally to clamping and lifting tongs, and more particularly to tongs for use in removing separators from storage batteries. The separators include a pair of pivoted shanks, having elongated thin and fat extensions at one side of the pivot, and extending handles at the opposite side of the pivot.

ELECTRIC FLOWER LAMP.—H. L. LANSING and J. R. KOHLS, 410 Eddy St., San Francisco, Calif. An object of the invention is to provide a combination of an electric lamp, a lamp shade, and a flower pot, in which the flowers receive light and heat from the electric light, in which the distance of the lamps from the flowers can be adjusted and which will be particularly pleasing in appearance.

APPARATUS FOR RENDERING METAL HOMOGENEOUS.—J. D. MCNEILL, 9850 Charles St., Chicago., Ill. An object of the invention is to provide a device by means of which metal which is being cast may be subjected to electro-magnetic influence, whereby a readjustment of the molecules of the metal is obtained in such a manner as to render the molded article more homogeneous than it would otherwise be. A further object is to provide a device in which the electro-magnet device is readily removed or applied at will.

VARIABLE ELECTROSTATIC CONDENSER.—G. F. JOHNSON, Springfield, Ill. An object of the invention is to provide means for maintaining the movable or rotor member of the condenser against accidental movement after adjustment. A further object is to provide a condenser with a star-shaped spring exerting a frictional contact to hold the plates of the rotor of the condenser accurately and permanently centered with reference to the plates of the stationary member.

STORAGE BATTERY.—P. M. MARKO, 1407 Atlantic Ave., Brooklyn, N. Y. Among the objects of this invention is to construct a battery with means for easily removing any of the cells for inspection, examination, repair or interchange. Another object is to provide means whereby it is practically impossible for the several cells to be connected except in a proper positive to negative manner.

Of Interest to Farmers

BEEHIVE.—T. K. MASSIE, Hatcher, W. Va. Among the objects of the invention is to provide a hive including a bottom-board of such design that when placed in a level position on the hive stand it will keep the hive perfectly level and result in perfect combs being built by the bees; the bottom-board includes a sloping floor for drainage of moisture to the front, ventilation is provided, and a dead air space next to the walls keeping the interior cool in summer, and protecting the bees in winter.

BEET AND VEGETABLE HARVESTER.—C. M. EWING and H. N. BRYAN, McComb, Ohio. Among the objects of this invention is to provide an implement for harvesting beets and vegetables which will eliminate hand labor and will thoroughly gather the crop from several rows to a single windrow or pile, ready for further operations, thus saving both time and labor. The parts of the device are adjustable so as to be adapted to various conditions.

DISK PLOW AND THE LIKE.—S. YUASA, 628 N. 6th St., San Jose, Calif. This invention contemplates an apparatus in the nature of an auxiliary disk plow comprising two longitudinal frame members pivotally connected, and a disk secured to the rearward member, and means for adjustment whereby the position of the disk may be changed relative to the line of draft, that a furrow may be made close to a tree or along a fence line.

DOOR AND DOOR FRAME FOR GRAIN BINS.—L. H. DICKELMAN, c/o The Dickelman Mfg. Co., Forest, Ohio. One of the foremost objects of the invention is to provide means whereby a corrugated door can be made to fit tight in the opening of a corrugated grain bin so as to prevent the entry of mice and the leakage of grain. A further object is to provide a drip table which extends beyond the door top, and door facings bent to produce the required rigidity, and do away with angle iron braces.

WIRELESS CORN PLANTER.—C. J. ARNOLD, Carthage, So. Dak. The invention relates particularly to a corn planter in which a wire as the means for actuating the seed dropping mechanism is done away with, and an arrangement of markers provided to be manually controlled in unison with the seed dropping mechanism, such means being optionally operative to throw the machine into or out of operation as desired, and whereby the machine may be steered round obstructions.

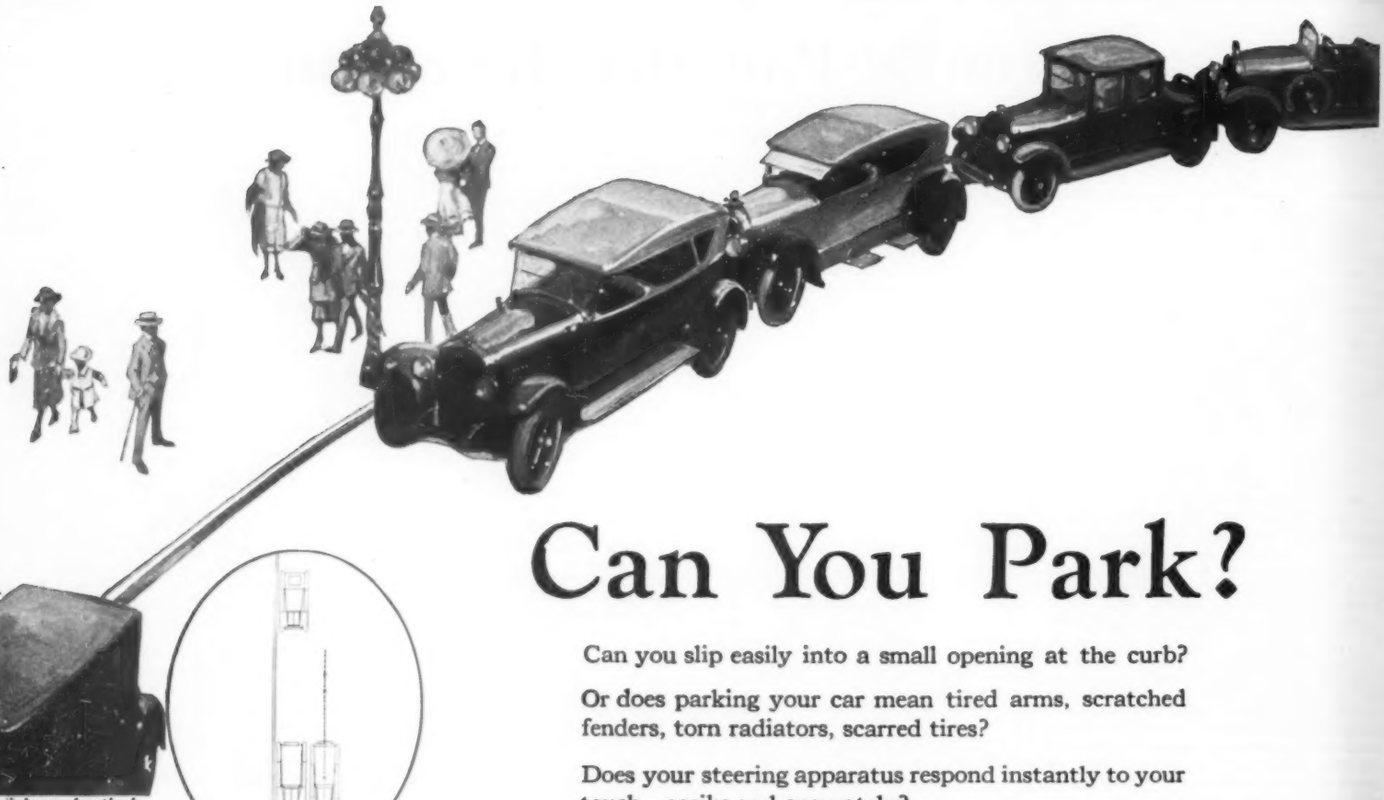
Of General Interest

BOOKMARK.—A. GRIMM, 24 Monmouth St., Newark, N. J. The object of the invention is to provide a bookmark which is provided with means for indicating any desired page, and which has, integral with the pointer, either a design of any shape, or a desk-shaped portion on which advertising matter may be stamped.

HAIR-PUFF DEVICE.—IDA W. STRAHAN, 137 Gordonhurst Ave., Montclair, N. J. The invention aims to provide a device by means of which puffs may be formed, and which will also be capable of being placed in position upon the head of the wearer after the hair has been dressed, and will not in the least be detrimental to the health of the wearer or the hair.

PERSPECTOSCOPE.—HENRIETTA GINSBURG, 1007 Montana St., El Paso, Texas. An object of the invention is to provide a

(Continued on page 272)



Can You Park?

Can you slip easily into a small opening at the curb?

Or does parking your car mean tired arms, scratched fenders, torn radiators, scarred tires?

Does your steering apparatus respond instantly to your touch—easily and accurately?

Or does the dread of parking often keep women—and men—from utilizing their motor cars as much as they would—as they should.

Parking is a part of auto-driving. And it should be studied and mastered just as such important operations as gear-shifting, braking, steering are learned.

Once the method is known parking becomes simply a matter of "nice-steering".

Accurate, comfortable, instantly-controlled steering—in a word, "nice-steering"—is certain in those cars with Timken Tapered Roller Bearings in the steering pivots.

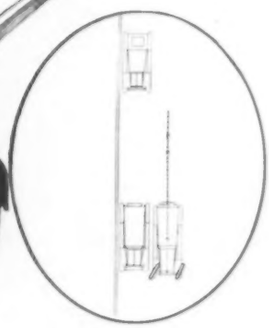
For many years the majority of big trucks have had Timkenized steering pivots because such cumbersome loads *must* steer easily.

The woman's car, also, *must* steer and park easily.

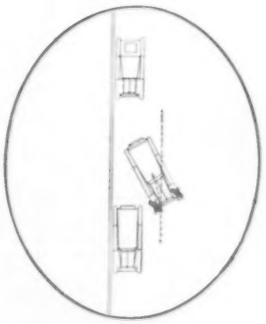
Timkens in the steering pivots will do it!

The Timken Roller Bearing Company
CANTON, OHIO

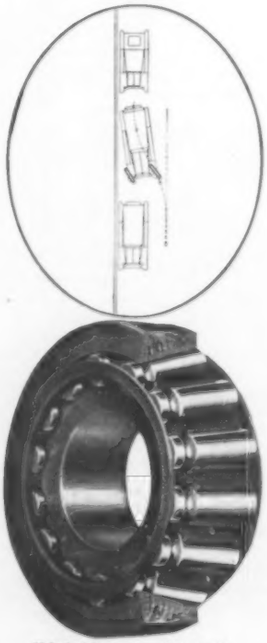
An easily learned method of proper parking in a limited space is to stop parallel to the curb alongside of the car behind which you are going to park, about one foot outside of it; turn the front wheels sharply to the curb and



back slowly until you can see that by swinging the front wheels hard over to the left, your right front fender will just clear the left rear fender of car ahead; turn wheels fully to the left and



back to proper position at curb. This method, once you know positions at which extreme turns are to be made, will park you at the proper distance from curb and cars in one backward movement. It is plain that

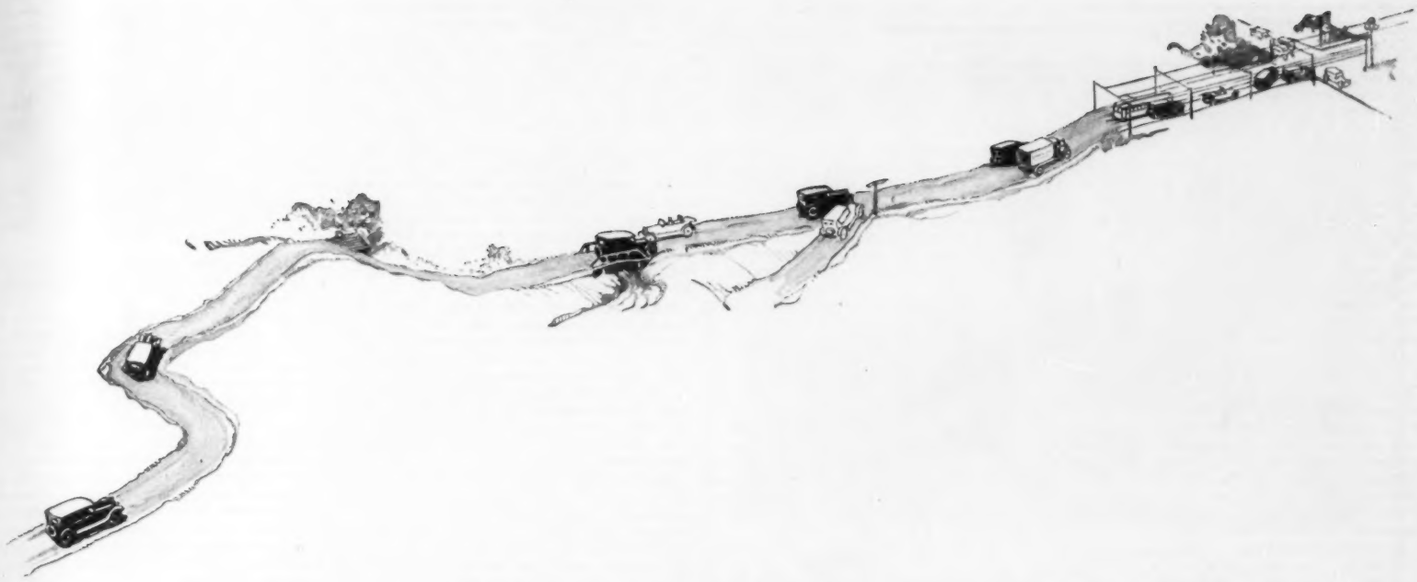


to execute these extreme turns in a minimum of space and time your steering apparatus must be in good working order. Ease of steering is made certain by the installation in the steering pivots of Timken Tapered Roller Bearings.

"Ask him to explain it"

TIMKEN
Tapered
ROLLER BEARINGS

© 1922, The Timken Roller Bearing Co, Canton, Ohio



Are You a "Nice-Steerer"?

Can you park your car—quickly and comfortably?

Can you safely judge steering distances by inches?

Can you avoid small holes and bumps without wearing yourself out?

Can you "ride the crests" of rutted country roads?

Can you drive in and out of traffic lanes, past street cars, around trucks, through "jams" with ease and safety?

Are you a "nice-steerer"?

Does a "twist of the wrist" suffice to put your wheels "hard over"—or must you tug and yank?

"Nice-steering" means putting your car where it should be with the least time and effort wasted.

"Nice-steering" means (1) properly inflated tires (2) properly lubricated and properly adjusted steering gear and (3) Timken Tapered Roller Bearings in the steering pivots.

Hard steering is dangerous. Foresight in the purchase of a new car will eliminate it.

Trucks, which must steer easily and accurately, have been equipped with Timkens in the steering pivots for years.

The taxicabs of the Yellow Cab Company of Chicago, whose drivers are known everywhere for their driving skill, their "nice-steering", also have Timkens in the steering pivots.

Every driver, man or woman, can be a "nice-steerer".

Timkens in the steering pivots provide that ease of handling that makes parking easy, keeps you out of small ruts, "on the crests," in your place in traffic—with effortless comfort.

Hold the steering wheel this way, says "Cannon Ball" Baker, famous transcontinental driver, and your control will be absolute, yet comfortable. Spark, throttle, gear lever, horn, lights, and emergency brake are most convenient.

Whatever your position at the wheel, Timken Tapered Roller Bearings in the Steering Pivots make steering easier and safer.

SEND FOR THE BOOKLET, "NICE STEERING"

"Ask him to explain it"

The Timken Roller Bearing Co
CANTON, OHIO

TIMKEN
Tapered
ROLLER BEARINGS

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Of General Interest

(*Continued from page 269*)

transparent device which will be of material assistance to students of art, and to provide a sheet of paper having markings thereon corresponding to the markings on the perspectoscope, so that by looking through the perspectoscope an object may be reproduced upon the paper in its true proportions.

PHONOGRAPH RECORD HOLDER.—A. WENGER, 432 Broadway, Bayonne, N. J. The invention relates to holders for phonograph disc records, its object being to provide means for supporting and indexing records within a record cabinet or housing whereby to facilitate the storing, removal, and locating of the desired record in a minimum of time, by means of a supporting arm bearing an indicating card.

ELEVATOR-DOOR CONSTRUCTION.—J. C. HEINZELMAN, 3245 W. 66th Place, Chicago, Ill. An object of the invention is to provide a door of the folding or jack-knife type for elevators, the frame arranged with its inner face substantially flush with the inner wall of the elevator shaft, whereby the space between the car and the walls of the shaft may be reduced to a minimum, thereby obviating the necessity for providing the usual so-called trucking sill.

LIFE PRESERVER.—J. STROBEL, 11122 Spruce St., Glen Morris, L. I., N. Y. The invention relates to a life belt which includes an air chamber. An object is to provide a form of valve for preventing the escape of air from, or the entrance of water into the chamber, and means for actuating the valve. A further object is to provide means permitting of rapidly donning of the belt, and for holding the belt in collapsed position when not in use.

CHARTOMETER.—W. E. C. PETERSEN, 3443 W. 66th St., Chicago, Ill. An object of the invention is to provide a form of measuring device for quickly and accurately determining the distance between points on scale drawings, charts, and the like. A further object is to provide a device that is compact in form and which can be readily operable by one person, without the necessity of marking the drawing in any way.

SANITARY BOTTLE TOP.—C. LUSTGARTEN, 3354 Lexington St., Chicago, Ill. Among the objects is to provide a metal top for use with milk bottles which is provided with a resilient air-tight closure, and which may be opened by the hand that grasps the bottle, thus allowing one to open and pour with one hand into a receptacle held by the other hand.

FINGER-NAIL BUFFER.—H. E. DAVIS, 207 Huntington Ave., Boston, Mass. The invention has for its object to provide a device which is simple and durable in construction and attractive in appearance, which is easily assembled and disassembled to renew or lighten the buffing or covering material and which is adapted to efficiently grip the covering material and retain it taut and in proper position on the buffing surface.

INDEX TAB.—R. J. TURNER, c/o Efficiency File Co., 645 Battery St., San Francisco, Calif. The invention relates to index tabs, such as are commonly used in filing systems, books of accounting or similar books. The object is to render the tabs less expensive for manufacture, and provide an easier way than is usual for attaching the same in their places.

MANUFACTURE OF REENFORCEMENTS FOR WOODEN POLES, MASTS, ETC., WHICH ARE SET IN THE GROUND AND HAVE BEEN DAMAGED BY WEATHER INFLUENCES.—F. JAECKLE and P. MEHLHORN, Freiburg, Germany. The object of the invention is to provide a method of repairing poles, masts, etc., which have been damaged by weather influences, and consists in anchoring a metal armor in a concrete base about the poles, securing the armor to the pole above the damaged portion, severing the pole above and below the damaged portion and removing the same, and placing cement in the space occupied by the removed damaged portion.

SAFETY RAZOR.—W. T. KLAUBERG, deceased, address Klauberg Bros., Woolworth Bldg., New York, N. Y. Among the objects is to provide a razor to produce what is technically known as an "angular stroke," and to provide guard teeth angularly disposed, with relation to the line of the edge of the blade and extending in the direction of the movement of the razor when producing the so-called diagonal or angular stroke.

NONREMOVABLE CORK.—L. CRANE, 1670 Boston Road, New York, N. Y. The invention has particular reference to a non-removable cork which is adapted to be applied to bottles or receptacles containing poison. The object is to provide a simple device which can be attached to the cork of any bottle in such manner that the removal of the cork without the possession of certain specific means is impossible.

OIL PROJECTILE.—E. R. and O. H. CRAMER, c/o O. H. Cramer, 79 Edgewater Place, Edgewater, N. J. The invention relates to means for calming the sea by oil. The principal object is to provide a projectile adapted to contain a quantity of oil which can be fired from the usual mortar used for the purpose of projecting life lines whereby the oil contained may be released an appropriate distance from the vessel on the windward side.

VANITY CASE ASSEMBLAGE.—A. LENNEBERG, 99 Wicks Ave., Yonkers, N. Y. The invention has for its object to provide an attaching frame including a box-like body which may constitute a vanity case or a coin holder. The arrangement is such that the body may be detached leaving a cover frame on the open securing frame for the viewing of a watch, or the cover frame with the body detachably held may be disengaged from the securing frame to constitute in itself a portable vanity case. The device may be attached to a glove or handbag.

FOLDING CAMP TABLE.—B. B. DUDLEY, Visalia, Calif. The invention has for its primary object to provide a table which may be folded and conveniently carried upon the running board of an automobile. Among the features are a construction which will enable the table when folded to act in the capacity of a carrying compartment for various camping accessories, even foodstuffs, cooking equipment, and the like, and to associate the table with at least two chairs or stools.

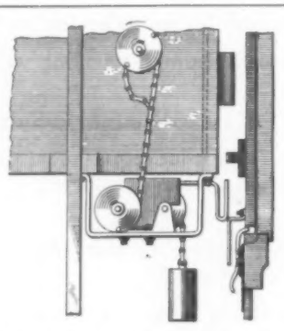

Fig. 1: The safety elevator lock invented by W. S. Campbell

Fig. 2: Can cover, designed by H. P. Ciesielska, especially for milk cans

FISH STRINGER.—T. B. MCNIECE, c/o F. L. Garrison, 541 First National Bank Bldg., Cincinnati, Ohio. An important object of this invention is to provide a stringer comprising a barrel, a light chain and a pin which may be forced through the head of the fish and extended into the forward portion of the tubular barrel so as to form a semi-circular loop, and a handle by which the fish may be carried. The device occupies but little space and may be conveniently carried with the other tackle.

AUTOMATIC FIREARM.—J. J. REIFGRABER, 6460 Marmaduke Ave., Clifton Heights, St. Louis, Mo. The foremost object of the invention is to provide a one-hand automatic pistol which, as the term implies, is capable of being relieved so that the operator may continue shooting in case of a "misfire," or "jam," and not require the other hand to aid this function. A further object is to provide a pistol with normally locked breech-lock, but so arranged that the breech-lock is unlocked by virtue of the pressure of a fraction of the gas following the bullet discharge.

DISPLAY STAND FOR DISCHARGE CERTIFICATES.—C. L. HOUSEHOLDER, 316 McCowat-Mercer Bldg., Jackson, Tenn. One of the principal objects of the invention is to provide a stand for the attractive display of the certificates of honorable discharge of men in military or naval service. Another object is to provide a frame which is rotatably mounted upon a base in such manner that it may be turned to be viewed from different angles.

CHEESE MOLD.—S. FIELDMAN, 171 Broome St., New York, N. Y. The general object of the invention is to provide a cheese mold in which ample provision is made for the escape of the whey from the mold when in the press, and whereby to promote convenience in the assembling and disassembling of the mold and placing and removing the cheese, as well as to make provision for ready and thorough cleaning of the mold.

TYPE BOX.—W. A. SEARS, Leon, Kans. An object of the invention is to provide a packing case particularly designed for shipping linotype slugs, which will be easy to open and will obviate the inconvenience of pied type often caused by careless handling and shipment in fragile containers. The box is strong and practical, and special locking means are provided.

SOAP HOLDER.—F. MEEKS, 143½ So. Broadway, Los Angeles, Calif. An important object of the invention is to provide a cake of soap having its ends formed with flexible loops, made from the same piece of tape passing through the soap, and adapted to be engaged by the thumb and little finger so that the cake of soap may be firmly held in the palm of one hand and will be thereby prevented from slipping.

ELEVATOR LOCK.—W. S. CAMPBELL, 505 Ridge Ave., New Kensington, Pa. The inventor has been granted three patents of a similar nature. One of the foremost objects being to provide an elevator door lock, for use on both passenger and freight elevators, which is so arranged that the power cannot be turned on until the door is closed and locked. A further object is to provide means making the device adaptable in elevators where two doors are used, so that both doors may be simultaneously operated by the power controller of the elevator. A still further object is to provide means for preventing the gates being opened except when the elevator is ready to receive freight, and to prevent the elevator being moved until the gate is securely fastened. (See Fig. 1.)

THERMOMETER CASE.—C. R. WALLENDORF, c/o C. J. Kessling, Kessling Thermometer Co., 96 Suydam St., Brooklyn, N. Y. The prime object of the invention is to provide a case for thermometers by means of which the thermometer may be subjected to centrifugal action in order to facilitate the shaking down of the mercury before a reading is taken; and to so construct the case that the thermometer will be protected against accidental breakage.

PHOTOGRAPHIC PRINTING APPARATUS.—R. D. MONIGER, decd., address Annie R. Moniger, 16 Sherman Ave., Washington, Pa. The invention relates to a photographic printing apparatus which includes a table with a transparent support in the form of a sheet of glass for the support of the paper and negative, a light chamber fitted with electric bulb beneath the support, a presser coacting with the support, a bell-crank lever whereby the presser is urged into contact with the support at all positions.

MANHOLE FRAME AND COVER.—L. GSCHWIND, c/o Sanitary Sewer Co., 549 Washington Blvd., Chicago, Ill. An object of the invention is to provide a form of manhole frame and cover in which a vertically adjustable inner frame fits within an outer frame. A further object is to provide a device in which means is provided for locking the cover in position, and unlocking the cover at will.

CAN COVER.—HELENA P. CIESIELSKA, Bear Valley Ranch, San Miguel, Calif. This invention relates more particularly to covers for milk cans such as usually contain condensed milk. The object is to provide a convenient form of cover which can be used to protect the milk and keep the same in good condition after the can has been opened. The cover provides means whereby the can may be closed immediately after each time that the milk is used, thus preserving the milk for a long time. (See Fig. 2.)

TICKET HOLDER.—H. and L. HOPP, 230 W. 17th St., New York, N. Y. The invention more particularly relates to devices adapted for holding price tickets. Among the objects is to provide a holder which may be securely fastened to the edge of a shelf or similar structure, against accidental displacement, and by a resilient tongue formed from a single piece of material.

FOLDER FOR CLOTH SAMPLES.—R. A. HOWARD, 122 N. 4th St., Oldtown, Me. The invention relates to a folder for parcel post packages, for mailing sample pieces of cloth or other fabric. The general object is to provide a folder so constructed that the package may be conveniently and securely enfolded and tied and the sample will be preserved intact.

ARTIFICIAL TOOTH.—S. L. GREENBERG, 110 W. 113th St., New York, N. Y. This invention has particular reference to a simple and efficient means whereby the insertion or removal of such teeth from the jaw is readily achieved. Another object is to provide teeth so constructed that they readily cooperate with a mounting as to the ease with which they are placed thereon and removed therefrom.

FOUNTAIN PEN.—A. O. DAHLBERG, Engineering Bldg., University of Wisconsin, Madison, Wis. The invention relates to self-filling fountain pens of the plunger type. An object is to provide a pen in which the ink may be pumped directly into the barrel. A further object is to provide a device which is simple, has few parts, and is not likely to get out of order easily.

DIE.—M. L. KAUFMAN, 469 7th Ave., New York, N. Y. The invention has for an object the provision of a die which can be used in many forms of games. A further object is the provision of a die having a plurality of geometrical sides on each of which a suitable character is so placed whereby the possibility in rolling the die of certain characters turning up is greatly diminished.

RING AND PLATE THEREFOR.—R. ROSENTHAL, 15 John St., New York, N. Y. The invention relates to a finger ring and an interchangeable ornamented plate associated therewith. An object is to provide a ring with a depression for receiving an enameled plate and ornament, the entire arrangement being so constructed as to properly fit together and present a stud adapted to be secured to the ring body in a manner to be readily removed.

CRIB.—M. DEMLINGER, c/o Hub Metal Bed Co., 1435 W. 37th St., Chicago, Ill. An object of the invention is to provide a child's crib that can be folded into compact form for convenient transporting and storing, and consisting of relatively few parts. A further object is to provide a crib having sides and ends, equipped with screens, foldable into adjacent horizontal planes and means for locking the sides and ends together to preclude movement.

TICKET.—C. A. LICK, address Weldon, Williams and Lick, Fort Smith, Ark. The invention more particularly relates to strip tickets which are arranged in book form and maintained flat, as distinguished from tickets wound on a roll. An object is to provide a ticket which can be conveniently torn off with one hand, leaving the other hand free for making change, and which will prevent fraud in the sale, as the tickets must be torn off in consecutive order.

BUILDING BLOCK.—A. H. ROETH, 105 Mt. Hope St., Bronx, N. Y. An object of the invention is to provide interlocking building blocks with locking means carried by the blocks which permit locking of the blocks when the same are placed at various distances apart, so that the same sized blocks may be used to form hollow walls of different widths. The blocks are simple and practical in construction, and damp-resisting in use.

FEEDING DEVICE.—W. L. COULTAS, JR., 1026 Jefferson St., Hoboken, N. J. The invention relates to a feeding device controlled by a float-operated valve. The arm carrying the float may be set so that fluid entering the reservoir may reach a certain predetermined level, at which time the valve controlled by the float closes to prevent the entrance of further fluid, the amount of fluid retained within the reservoir is thus incapable of variation.

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Information Leaflet Issued By Patent Office

AMONG the numerous and excellent innovations in Patent Office practice and procedure, for which the present Commissioner, Mr. Robertson, is responsible, is the preparation of a booklet of general information concerning patents, which is sent gratis to inventors. Naturally, many individuals not familiar with patent matters write to the office for information on almost every conceivable subject relating to patent protection. As it is not feasible for the Patent Office to reply to all such inquiries in full, the booklet above referred to has been prepared and is sent in each case to an inquirer. It contains much general information, but does not give all the rules of practice, though some are included in abbreviated form.

From the information thus disseminated we quote the following:

"A patent grant gives the inventor the right to exclude all others from making, using, or selling his invention for the term of 17 years, but it does not give the patentee the right to make, use and sell his own invention if it is an improvement on some unexpired patent whose claims are infringed thereby."

"There have been issued almost one and one-half million patents covering every possible line of inventive endeavor, and it is advisable, before applying for a patent, to have a search made to make certain that the device is not shown in some prior patent."

"An application for a patent must be made by the inventor only, and no person who has actually created a portion of the invention is entitled to be considered a joint inventor. A patent issued to more than one inventor where only one has actually invented the device is invalid. A person who makes a financial contribution merely is not a joint inventor, but the invention may be assigned to him."

"The preparation of an application is a highly complex proceeding and generally cannot be conducted properly except by an attorney trained in this specialized practice. The inventor, therefore, is advised to employ a competent patent attorney, as without skillful preparation of the specification and claims, a patent grant is of doubtful value. A register of attorneys is kept in this office. No attorney not registered in this office will be permitted to prosecute applications."

"The Patent Office cannot give any information concerning the utility and novelty of a device and cannot make any searches except upon a regularly filed application, accompanied by the necessary fee. It cannot give any legal advice regarding the practice, nor discuss legal questions except in connection with, and as part of, the procedure in a regularly filed application."

"Of the propriety of making an application for a patent the inventor must judge for himself. The office is open to him, and its records pertaining to all patents granted may be inspected either by himself or by anyone he may call to his aid, and its reports are widely distributed. Further than this the office can render him no assistance until his case comes regularly before it in the manner prescribed by law."

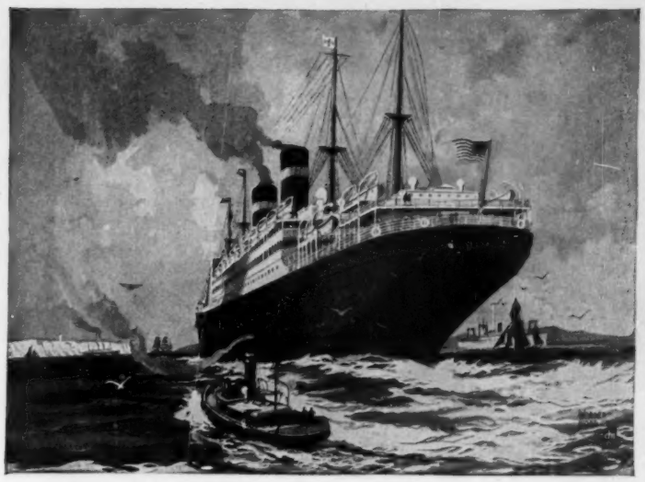
"Patents are not granted for useless devices, for printed matter, for methods of doing business, for improvements in devices which are the result of mere mechanical skill, nor for machines that will not operate, particularly for alleged perpetual-motion machines."

"A patent is not granted for a new composition of matter unless the component parts thereof, as well as the manner of making and using the same, are fully disclosed in the application when filed. To obtain a patent for a medical compound, it must be something more than a physician's prescription."

"No protection is afforded by the patent law prior to the actual issue of a patent. The terms "Patent applied for" and "Patent pending" have no effect in law, but give information that an application has been filed in this office. This office can give no advice as to the advisability of manufacturing and selling a device before a patent is issued."

"Once a patent has been issued it is out of the jurisdiction of the Patent Office, and, therefore, the office is not concerned with questions of infringement, the scope of a patent, or any other questions that arise out of the grant."

"Protection of the patent law extends throughout continental United States, Alaska, Hawaii, the Virgin Isles, Guam, and the Canal Zone, and, upon compliance with certain regulations, to Porto Rico and the Philippine Islands."



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Electrical Notes

Summaries and Excerpts from Current Periodicals

Small Circuit Breakers in Place of Fuses.—In Europe, and more particularly in Holland, the usual fuse is being replaced by an ingenious form of circuit breaker for the protection of domestic and industrial circuits. With the cover in place, the circuit breaker has much the appearance of the usual snap switch, and it is adjustable for currents of from 6 to 25 amperes. When the little circuit breaker is set, an indicator shows a black marker, but when the circuit breaker has opened the circuit, a red marker indicates the fact. A simple turn of a handle resets the breaker.

Heating of Hydro-Electric Plants.—From a Swiss electrical periodical we learn that 5 per cent of the water-turbine energy transformed into electric power in the generator is, on an average, converted into heat and imparted to the air. In two Swiss plants this heat is being utilized by a carefully laid out hot-air heating system which keeps all the rooms of the entire power station at a satisfactory temperature during the winter months. The generator capacities of these two plants are 25,000 and 50,000 kilowatts, respectively. Specially installed blowers force the circulation of the heated air through an elaborate system of air ducts, ending in registers in the different rooms.

The Nature of Speech and Its Interpretation is discussed by Harvey Fletcher in a recent issue of the *Journal of the Franklin Institute.* It is now possible to produce speech sounds at varying degrees of loudness and with definitely known amounts of distortion by electrical means. A method has been developed for measuring quantitatively the ability of the ear to interpret the transmitted speech sounds under different conditions of distortion and loudness. It was found that the intensity of undistorted speech which is received by the ear can be varied from one hundred times greater to one-millionth less than the initial speech intensity without noticeably affecting its interpretation. Apparatus designed to reproduce speech and preserve all of its characteristic qualities must transmit frequencies of from 100 to above 5000 cycles with approximately the same efficiency.

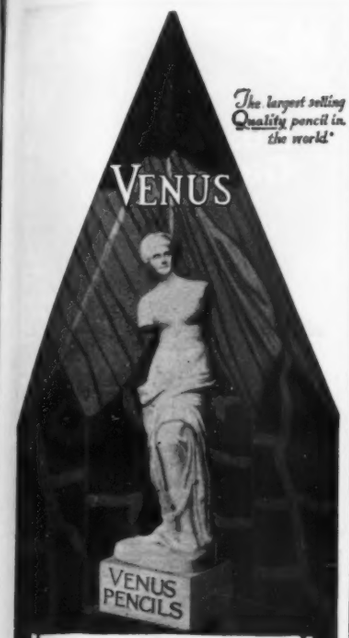
Color of Walls and Ceilings on Resultant Illumination.—No matter how carefully designed a lighting system may be as to type and size of lamps, type and make of reflector, spacing height, and so on, if the surroundings are not adapted to reflecting such light as strikes them, then an inefficient system may result. The ceiling and wall surfaces in a room are secondary sources of light, and merely increasing the reflection coefficient of the ceiling a slight amount may greatly increase the effective illumination. It is important that the ceilings be as light in color as possible. The actual finish must also be considered, as a glossy surface introduces glare, and a flat or matte finish is essential. Gloss enamel produces a glaring surface, while flat enamel overcomes this objection and is easy to clean. The paint must be composed of chemically inert substances ground exceedingly fine to produce density and mixed with an inert vehicle which is impervious and non-porous when dry. For these facts we are indebted to the Edison Lamp Works.

Electrification of the French Railways.—Details of the scheme to electrify the whole of the French railway system were recently given in an interview with M. le Trocquer, Minister of Public Works, who stated that after an exhaustive inquiry confirmed by the visit of a technical mission to the United States, it had been decided to electrify the whole railway system, thereby reducing the running costs and obviating the import of foreign coal. The direct current system of 1500 volts would be used, but it would be possible to employ either the third rail or overhead wire. Already various companies have begun work on the electrification of their more important sections. The system of the Midi Company will be completed first, probably in 1926, owing to the water-power available in the Pyrenees. The Orleans line has also made good progress and in four years the line from Paris to Brive, with many branch lines, will have been electrified. If nothing unforeseen happens to hinder the work the whole of France below the basin of the Loire will be served by electrified railways within twenty years' time. The economy in coal alone will amount to 3,000,000 tons per annum.

The Cables and the Future.—When radio telegraphy first made its appearance it was generally believed that the cables were doomed. Yet the fact remains that despite the constant improvement in radio communication methods, the cables not only have held their own but continue to expand. More and more cables are being laid year by year. According to Dr. H. W. Malcolm, a British authority on cables and the author of "The Theory of the Submarine Telegraph and Telephone Cable," "the possibilities in the future of cable telegraphy in its own sphere are as brilliant as are those of wireless telegraphy. Although the difficulties in the way of their realization must not be underestimated, none appear to be insuperable. Their speedy translation into fact is a task worthy of the greatest efforts of the engineers to whom it is intrusted. But much depends upon the manner in which they are supported. Given the spirit of indomitable perseverance, the commercial large-mindedness, and the scientific intelligence which alone made Atlantic telegraphy possible, there can be but little question that cable telegraphy is about to enter upon a period in which all its past achievements will be excelled."

Death by Electricity is caused from paralysis of all muscles, including the involuntary muscles of the heart, lungs, etc., as well as the destruction to the mental and nervous systems of the body, according to George M. Ogle, power representative of a large electric power company, writing in a recent issue of *Electrical World.* It has been found, continues this authority, through exhaustive research work, that a current of one ampere passing through the brain or other vital organs of the body will in most cases produce death if allowed to act for only a short period of time, and it is therefore evident that it is the amperage, together with the energy dissipated in the body, that actually destroys life. On the other hand, the element of voltage enters, inasmuch as the resisting power of the human body is very high and it requires a voltage comparatively large or small, depending entirely upon the resistance and contacts, to force this amount of current through a circuit in which the body and its contacts constitute the resistance. The resistance of the human body is a variable factor and depends largely upon the applied voltage, inasmuch as the resistance measured from hand to hand with precision instruments on potentials not in excess of 10 volts will show approximately 40,000 ohms, while if this potential is increased to 110 volts the resistance breaks down to some extent and becomes nearly 10,000 ohms.

Electric Fires and Their Origin.—The salient features of a report on the electrical fires of 1920 are covered in a recent issue of *Electrical World,* and may be summed up as follows: 1. Coincident with the rapid introduction and extension of electric service, some reduction in the proportion of fires of electrical origin is apparent, indicating that the introduction of electric service is in reality a safety movement and in itself does not introduce a fire hazard. 2. The liability of fires attributable to the use of electric service is not susceptible to measurement by general averages, but is governed by local conditions which are controllable to a considerable extent. 3. The liability to fires of electrical origin in individual communities places the communities in well-defined groups in which the electric fire risk can be measured with considerable accuracy—the ranking being established by the records of previous years. Consequently, a system of classification of communities according to their liability to electric fires would unquestionably have a tendency to bring about better inspection and regulation methods in the individual communities in an attempt to improve their ranking. 4. A suitable classification of electric fires in civic and insurance reports will serve to indicate the responsibility for an excessive number of fires in any particular class, permitting the introduction of suitable remedial measures and the enforcement of suitable regulations.



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Miscellaneous Notes

Emery Fabric.—Wove cellulose yarn from fibrous paper pulp, being devoid of fat, adheres strongly to the glue that secures the abrasive to the fabric.

Animals and the Whip.—In England a committee investigating the treatment of performing animals finds much cruelty in the training methods. Animal lovers hope the committee may develop a practical plan for the betterment of conditions.

Badges for the British Navy.—The badge has long identified members of the crack British regiments, to good psychological effect. Brass plaques serving a similar purpose are now being furnished the navy, with the battleships set in heraldic devices.

A Concealed Statue.—There is in the Crystal Palace, near London, an equestrian statue 30 feet high. In 1859 it was decided to be too heavy to move, and the present grand orchestra was built up around it. Of the millions that frequent the Palace, few have any suspicion of the statue's existence.

New Foreign Postage Regulation.—Business letters addressed to points abroad and bearing insufficient postage do not now leave this country; they are returned to the sender from the mailing office, marked "Returned for Additional Postage." The stamps originally fixed will, when the letter is again mailed, be accepted to their face value toward payment of postage.

Newsprint Again Cut.—The third reduction in price within a year occurred when the International Paper Company announced a drop of $15 a ton, making the new quotation $80 a ton; this is $50 less than the peak quotation of 1920-1921, and is only $4.95 more than the price fixed by the Federal Trade Commission during the time of Government control.

Lead Poisoning Among Pottery Workers.—The report of the United States Public Health Service on this subject is now in press. The danger is chiefly to those handling the glaze; the lead is inhaled as dust, the lungs absorb lead from fumes, and there is some absorption through the skin. The use of leadless glazes, already established in European factories, would remedy the trouble, but this requires sweeping changes in our manufacturing and firing methods.

Cement in 1919.—The war years were marked by declines in the output of hydraulic cement, but 1919 showed good gains both in production and shipments. Production in Portland cement increased 14 per cent in quantity and 21 per cent in value, and shipments from the mills exceeded production. The quantity was 13,559,153 long tons and the price per ton $10.19. The plants engaged in this manufacture numbered 111 and our per capita consumption was about .77 barrel.

Our Films and French Chateaus.—American picture producers are offering to rent historic chateaus at 1,000,000 francs each for a period of 10 years, repairs and upkeep to be paid for by the producers. The film men would be able to house all their forces in the rented mansions, thus reducing overhead, and by the time the chateaus were returned to their impoverished owners they would have been advertised through thousands of films, and any desired sale should be readily negotiated.

Disposing of Our Wooden Ships.—A wooden vessel of the Shipping Board proved so lacking in speed that a consignment of meat spoiled on the voyage. The packers brought suit for $250,000, and the Board is now seeking to turn the vessel over to them in satisfaction of the claim. "We may get rid of one wood ship for $250,000," is the optimistic way in which a member of counsel of the Board looks at it. Thirty-three other wooden ships are involved in similar proceedings.

To Restore a Long Telegraph Line.—The overland telegraph route from London and Western Europe to the Levant, Persia and India, operated before the war by the Indo-European Cable Company, will be re-established shortly. From England the line will run to Emden, thence overland through Poland and Russia to Odessa and thence by cable to Constantinople, where the Indian connections will be made. Most of the Russian section of the line has been found to be in fairly good shape.

Fuel Briquets.—This industry made a record for output in 1920 with 567,192 net tons, exceeding the previous high-record year 1918 by 89,957 tons. Evidently, in face of the coal shortage and high prices, consumers eagerly turned to briquets. The value

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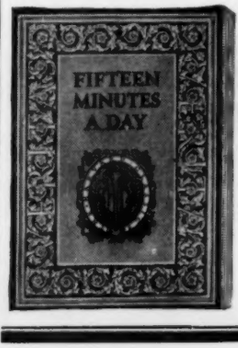

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of the 1920 output was $4,623,831, an increase of 43.9 per cent over 1918, and of 101 per cent over 1919. The average value per ton f.o.b. plant has risen from $4.90 in 1916 to $8.15 in 1920. In the latter year three new plants came into existence, making a total of 15 plants operating in the United States.

Longest Fire on Record.—The recent destruction by fire of the large Parisian department store known as the *Magasin au Printemps*, with damage estimated at 30,000,000 francs, recalls the interesting circumstance that when the original *Printemps* was similarly destroyed, fifteen years ago, firemen were sent from London to assist the "pompiers" of Paris. This later fire reduced to ashes a costly collection of Oriental rugs and tapestries, and a lavish display of the season's dresses. A thousand employes were deprived of work. Five bodies were reported to have been found, but later it was announced that these were elaborately-gowned wax models.

Source of the Baseball Bat. — Ash ideally combines the qualities demanded of the baseball bat. Shape and size are matters of individual taste—the model room of a leading manufactory has on show 1,200 bat patterns—but ash is really the one accepted material. Now, although we have resources of nearly 10,000,000,000 board feet, ash is popular for so many purposes that its scarcity has already greatly affected the price, and farmers with suitable woodland might well devote it to this tree. The U. S. Forest Service has originated and perfected a laminated bat built up of short pieces of ash joined with the same waterproof glue as is used in airplane propellers; these bats are said to be as resilient, durable and satisfactory as the one-piece kind.

Christening Commodities. — Products are often named from the places of their origin, though time frequently warps the name out of recognition. We trace muslin to Mussolo in Mesopotamia, cambric to Cambrai, calico to Calicut in India, damask to Damascus, and fustian to Fustat, Cairo. Gin, the corrupter, is itself corrupted from Geneva, while sherry by acrobatic evolutions leads us back to Xeres. Millinery is a bit obscure until we learn that a citizen of Milan was once called a milliner, and that millinery was women's finery imported from Milan. Currant derives from Corinth, poplin from Avignon, a *papal* town. Other names, such as champagne, china, morocco and arras retain their source-forms untwisted by time and foreign tongues.

Japanese Pearls Inferior.— Something approaching consternation swept the London market when it became known that the Japanese were producing what were declared to be real pearls by introducing into one oyster a particle of mother-of-pearl sewn up in shell-producing tissue taken from another oyster. New York jewelers were not so readily driven into panic, and they now state that the unnatural stimulation induced by the method results in a pearl of distinctly inferior quality; held to the light, the difference is readily seen. The surface lacks the lustre and pinkish glow of the natural pearl; it has a dead, waxy appearance, and the texture is not so fine. As an additional precaution the X-ray is used; this never fails to differentiate the natural from the forced variety, and shows the nucleus of the latter to be large and solid instead of small and often hollow, as are the cores of natural pearls.

How Pullman Cars are Named.—There is a legend which it is hard to down that Pullman cars are named by a member of the Pullman family for $5.00 a piece. This may have been the case in the early days, but not in our time. The Pullman Company has just made public some of the details of their system in the *Pullman Bulletin*. Sequence is the system. One name suggests another. Thus: "Ruth and Naomi, Venus and Adonis, Dewey and Manila." The first picker was biblical. Next came someone with classical thought. "Helen and Paris." Also "Trojan, Ilion, Achilles, Hector, Ajax, Nestor, Ulysses and Penelope." Then come selections from Dickens's characters; Kipling and his works; Walter Scott's characters; Indian names; Ireland and its counties; King Arthur and the Round Table Knights. To excite the palates of those who regret the passage of the Eighteenth Amendment there are the cars "Bourbon, Ryegate, Gordon, Manhattan, Moselle, Burgundy, Tokay, Yvette, Cohasset, Scotland and Bacchante." Hope is seen in the "Wetmore," but there is also "Aqua" and "Temperance."

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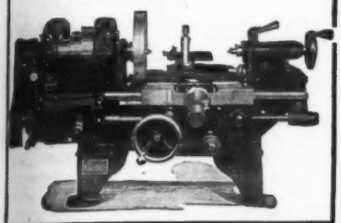

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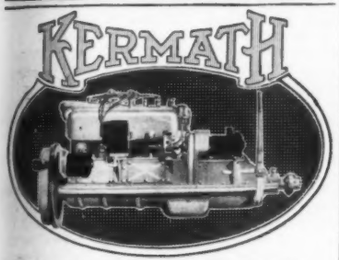

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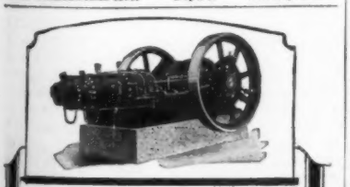

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Mechanical Engineering Notes

A Handy Tool is a little electric pencil-like affair, recently put out, which is doubtless of most value as an etcher for marking finished pieces, but which also has many applications as a demagnetizer, a spot-annealer and a soldering-iron.

Heating of Bearings.—By coating railway axles and bearings with a substance which changes color when hot, any heating is readily disclosed. Oil paint comprising a mercury-iodine-copper combination is red when cool and black when hot.

Air-Cooled Suit to Protect Welders.—This device, whose very name is almost self-explanatory, is described in a recent issue of the Journal of the Americal Welding Society. The air passes through the mesh of the fabric of which the suit is made, being supplied through a flexible tube fastened to the suit.

Clean Metal Parts.—It is frequently the case that a high percentage of rejections after japanning or plating, difficulties in assembling, and other factory troubles of a more or less conventional sort go uncorrected, when careful analysis would show that they are in large measure due to failure to keep the finished surfaces clean. Preparations are available for correcting this and keeping the product clean at all stages.

Enlarging Pistons by Plating.—Pistons whose service is such that a nickeled surface will be satisfactory may be renovated in this fashion with complete success, a surprising degree of under-size being easily overcome. Electro-plating is also very effective in the most delicate kinds of machine work. Any thickness of metal can be deposited on tiny shafts or in bearings so as to bring up the size to any degree of fineness. Some of the more careful model makers have long ago adopted this method of accurate work, using copper plating in some instances and gold in others.

Firm Seating of Nuts is something that is often not given the attention it deserves, and that, when it is properly done, is not always effected economically. It is not necessary to drive a nut home by wrestling with it through the agency of a big and awkward wrench of special pattern. Power nut-setting machines with flexible shafts enabling them to go to the work much as the dentist's drill goes to it, are now available and may be looked to to effect considerable savings on nut-setting operations that are not extensive enough to warrant the construction of a jig.

A Scaling Hammer.—Another recruit to the number of scale removers is forthcoming in the Sandblom electric scaling hammer. This Swedish invention is practically new to English-speaking countries. On the outer end of a spindle (1200 revolutions per minute) a number of small chains terminate in a small hammer head. A very light electric motor supplies the driving power. Centrifugal force throws the chains outwards, and with the spindle held near a steel plate the hammer heads strike 10,000 blows a minute. This is said to give better results than pneumatic or hand scaling. No one can question its rapidity.

Lubricating Loose Pulleys.—A correspondent of *American Machinist*, having noted the usual difficulty encountered in keeping loose pulleys lubricated, makes two suggestions of value. One involves the drilling of holes through the bushing, and the filling of these with a mixture of graphite and cylinder oil. The other is to drill several holes along the inside surface of the hub, parallel to the axis, and breaking through into the bore. In these are fitted soft pine plugs, soaked in oil, in such a way as to restore the inner bearing surface of the hub. Pulleys rendered self-lubricating in either of these ways will give no trouble for a period of years, it is stated.

Mercury Turbo-Generator Plant.—The Hartford (Conn.) electric lighting company has ordered a commercial mercury boiler and turbine plant for its Dutch Point generating station. The unit, which will be of 2,000 kva capacity, is claimed to be the first of its kind in the world. Fuel oil will be used, and it is expected to cut down the fuel consumption for the generation of current by 50 per cent. The *Electrical World* states that it is intended to install a mercury turbo-generator on the top of an oil-fired mercury boiler containing a charge of about 30,000 lb. of mercury. The turbine will be operated by the mercury vapor at rather low pressure, and the exhaust from the mercury turbine generates steam in a modified water tube boiler.

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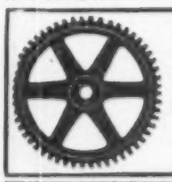

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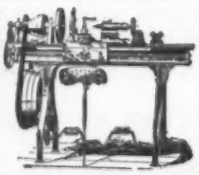

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Civil Engineering Notes

Abstracts of Important Recent Papers and Published Articles

Water Power in Japan.—Japan will construct a large hydroelectric plant on the Shinano River, with a capacity of 84,000 kilowatts, operating a 200-mile line. It is hoped to complete the plant by 1926.

Wet Hauling of Concrete is not so serious a matter as has been supposed, if we may judge from recent experiments of the Bureau of Public Roads. Concrete was hauled wet for periods as long as three hours and ten minutes, and then laid without appreciable loss of crushing strength. In fact, the best test was scored by a batch that had been wet-hauled for 2¾ hours.

A Hudson River Bridge at Bear Mountain is proposed, and has reached the stage where its construction seems probable. The span would be but 1650 feet. The bridge would be entirely in New York State, and would be operated privately as a toll passage. Traffic on it would presumably consist almost entirely of pleasure vehicles, since its connections on the west side would be through very mountainous country.

Data on Fireproof Buildings of extreme value will be the result of the fire in Chicago, March 14 and 15, when the upper seven stories of the fireproof Burlington building were gutted by a fire which entered from outside after melting wire-glass windows whose temperature of fusion is 1760 degrees Fahrenheit. The contents of the building were, of course, utterly destroyed, but the structure itself stood up very well, and its performance is most encouraging.

Map Scales formed the subject of an interesting discussion by an assistant chief engineer of the United States Forest Service in a recent issue of *Engineering News Record*. The author considers that a change from the present scale of 1:62.500 to an exact inch-to-the-mile scale would render the Geological Survey maps far more valuable. He indicates numerous Government departments which work on the inch-mile basis and which favor the change. The cost in accommodating existing maps would be less than $100,000.

Safety Congress at Detroit.—The annual Congress of the National Safety Council was held at Detroit August 28 to September 1. The activities of the 21 sections of the council were developed in various sessions, and there were also several general sessions which were given up to subjects of broader interest. The civil engineering topics included papers on safety methods for the guidance of field superintendents; the keeping of records of accidents; safety precautions in the erection of lofty steel buildings, the reduction of waste in construction work; and the work of industrial surgeons.

Another Monorail Experiment.—Another experiment with overhead monorails is to be made, according to the *Practical Engineer*. The French Ministry of Public Works has decided that an experimental line shall be installed in the Peronne district. The subject has been investigated by a commission, which issued a somewhat favorable report. If the experimental installation should prove successful it is proposed to provide a mono-railway between Paris and St. Germain. It is understood that the system is merely an aerial line carried on standards on which a car fitted with engine and propeller is mounted, and it is claimed that speeds up to 150 miles an hour can be reached.

The Distribution of Highway Traffic through the year is indicated in interesting fashion by the traffic census made on one of Connecticut's main highways for the 12 months from July, 1920, to June, 1921, inclusive. Almost exactly half the year's traffic was during the three months of June, July and August. Sunday traffic is exactly one-quarter of that for the entire week, the remaining three-quarters being distributed in a rather neat increasing range in both directions from Wednesday's minimum. The week-end traffic, whether it be regarded as of Friday to Sunday or of Saturday to Monday, inclusive, is well over half the total. Horse-drawn vehicles constitute but four-tenths of 1 per cent of the total.

Clearing the Plata Channel.—The Argentine Government has decided to decline all outside offers—of which many have been submitted—to clear the channel of the river Plata of the number of vessels (exceeding fifteen) which during the past few days have been wrecked there, and which constitute a continual danger to navigation. British engineering firms and contractors, as well as several foreign speculators, have made proposals at various periods to purchase the wrecks from the Government and to dynamite the hulls with a view to disposing of the various materials salved. These plans have also been rejected by the Government, which, through the Ministry of Marine, will carry out the work on its own account, the Public Works Department furnishing all necessary dredges and flat-boats.—*The Engineer.*

Reenforced-Concrete Boardwalk.—There is now being built along the sea-front at Coney Island, N. Y., a new boardwalk and bathing beach which involves some heavy engineering work. The city is putting in a boardwalk 9500 feet in length and 80 feet in width, or 20 feet wider than the widest section of the well-known Atlantic City boardwalk. The walk, which is carried upon a series of reinforced-concrete pile bents, 14 inches square by 28 feet long, is designed for a live load of 125 pounds per square foot, which is the maximum possible loading for a dense and heavy crowd. Extending into the sea are a series of groins built of sheet-piling and heavy rock fill. The contract includes the depositing of 1,700,000 cubic yards of sand fill between the inshore end of the groins and the boardwalk so as to form a new bathing beach.

Smooth Pavement far beyond what has been practical is attained with the use of an instrument designed by the Chief Engineer of the Minnesota Highway Department. The "straight-edge," as it is called, consists of a 2x4-inch bar, perforated with a hole midway of its length. Through this hole there passes a weighted pin which bears on the road surface. To the upper end of this pin is attached, by a 4-to-1 leverage arrangement, a horizontal arm. As the apparatus is dragged over the road, the bearing end of the weighted pin follows all depressions and humps in the surface and its vertical travel, magnified four times, is reproduced by the free end of the horizontal arm. Whenever this travel exceeds a set amount, which can be fixed in advance upon any basis of severity desired, the surface is rolled again.

Earth Fills in Place of Trestles are becoming more and more a feature of the slow and continual reconstruction of American railroads. The old trestle has nothing in its favor save original low cost, and this advantage is not as great as it once was, the price of timber having gone much further up than that of good, plain earth. The Missouri Pacific has since 1915 replaced with earth fills 21 trestles, aggregating 12,171 feet in length, and ranging in height up to 122 feet. Over four million cubic yards of material has thus been filled. The biggest single job undertaken by this line involved a trestle 2159 feet long and having a mean elevation of 57 feet. As throwing light upon the economics of the change, it is pointed out that the trestle, built new in 1904, had reached a stage of deterioration when complete reconstruction was necessary. The life of the fill, when properly maintained, is, of course, indefinite.

Interstate Engineering Projects always involve a good deal of politics and diplomacy, and the composition of more or less discordant views on the part of the engineering administration of the several States concerned, each of which usually wants to be the dog while the others play the role of the tail. This condition has reached a climax of absurdity in the case of the Hudson River Vehicular Tunnel, where it seems practically impossible to get either the New York or the New Jersey Commission to agree, without modifications, to any proposal originating with the other. The sole aim in life of the New York Commission seems to be the demonstration of its superior interest in the tunnel, and that of the Jersey body to be the kicking up of small clouds of annoying dust over the most insignificant details merely by way of emphasizing its equal interest and authority. The two States would do better to organize a single, disinterested body and put authority in its hands.

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Science Notes

Hybridizing the Ox.—Yak imported into Alaska will be crossed with Galloway cattle in an attempt to produce a meat animal that can withstand the hard winters of the far north.

No Time for Reflection.—French anglers are placing a tiny mirror just behind the bait; the fish is supposed to mistake its own image for another fish, and thus to be hurried into snatching the hook.

New Source of Tannin.—The donga tree of the Fiji Islands is to be commercially exploited; its bark contains a higher percentage of tannin than the famous Australian and South African wattle bark.

Sugar from Dahlias.—Levulose, a sugar made from the tuber of the dahlia, is exceptionally sweet and is said to be harmless to diabetics. The American Dahlia Society and the Bureau of Standards are cooperating in the development of its possibilities.

Radium Output to be Increased.—It is planned to raise the output of radium at Joachimsthal, near Carlsbad, to four grams annually. To this end an Anglo-American syndicate has been formed with ample capital. Most of this radium will find its way to English and American hospitals.

Rubber-Seed Oil.—An oil similar to linseed oil is extracted from the seed of rubber trees and the residue used as fodder. A mill has been set up in Malaya and small consignments have been sold in Europe at good prices. Under present conditions on the rubber plantations, seed for this purpose is easily secured.

Easter Lilies from Seed.—Easter lilies may readily be grown from seed at any season, if suitable moisture is maintained. Outdoor planting in northern climates should be in late autumn if spring germination is desired. Experiments by the Bureau of Plant Industry has made us independent of the Japanese bulbs, but until the trade puts seed on the market the gardener must procure imported bulbs in early winter or at Easter, and grow his own seed.

Buffalo Steak for the Market.—Before long our northwest lands unsuited to agriculture may maintain buffalo for food purposes. A western packer now has a herd of a thousand of these animals on 25,000 acres of wild-grass country between the Yakima and Columbia Rivers; they were brought by train from South Dakota, the price paid being $300 to $400 each. Every year a certain number will be slaughtered for the meat market, and the experiment will be watched with interest.

Saving Money Through Fossils.—The invertebrate fossil is the clock by which the geologist tells the time in history when the rock bed containing the fossil was formed. This clock has been put to practical uses. New York was spending thousands of dollars in search of anthracite coal beds, until geologists demonstrated that the beds in this State could not possibly contain coal. Fossils proved that the rock beds belong to the Devonian age, not the Carboniferous, and the useless expenditure of money at once ceased.

Fruit-Growing Researches.—The fruit interests of Michigan, uniting with the Michigan Agricultural College, will conduct experiments in an attempt to solve the problems of fruit growers. Tests with grapes and small fruits may determine the kinds and amounts of fertilizer to be used, and the number of buds to leave for the protection of the next crop. Other investigations will embrace peaches, apples and cherries, the cover crop returning most humus to the soil, and the disputed question of amount and kind of pruning for young trees.

Making Rats Exterminate Themselves.—Director George Jennison, of the Manchester Zoological Gardens, pronounces Great Britain's "rat week," when efforts were made to decimate the rats responsible for the destruction of $140,000,000 worth of food annually, to be a great mistake. The male rat, the bold rover, is the one caught by poison, and the death of males only improves living conditions for the survivors. Four male and six female rats will, under favorable conditions, increase to large proportions in a period of two years. Dr. Jennison's suggestion is to upset the numerical proportions between the sexes and leave the males to destroy their own kind; he would forbid the poisoning of rats, but would take them alive in traps, kill the females, and turn the males loose. He claims to have followed this method for years with success.

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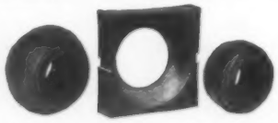
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Radio Notes

A Review and Commentary on the Progress in This Branch of Rapid Communication

Weather Reports for France.—The Eiffel Tower radio station at Paris is preparing to send out telegraphic weather reports and forecasts three times daily. A suggestion has been made that radio receiving sets be installed at central points in the various country communes and that the information thus received be signaled to the farmers by a code of sound signals from the church bells. For example, no signal if no change in the weather is forecast; three strokes of the bell if rain is expected; six strokes for frost; and ten strokes for wind or hail storms.

A Belgian High-Power Station.—Work is in progress on the first large radio station for international traffic in Belgium. Up to the present time the Belgian wireless service has been limited to reception from the high-power stations of other countries and distribution to points in Europe via land wire. The fact that the circuit was available only to traffic in one direction has prevented the development of the service. The completion of this new station at Bruges will make it possible to handle a considerable volume of the foreign communications of Belgium by radio. M. Charboncelle, the Belgian telegraph engineer, is experimenting with a high-speed transmission of written messages, the received message appearing in actual long hand equivalent to a photograph of the original written message filed at the transmitting station.

The Sainte Assise Radio Station, said to be the most powerful in existence, has just been opened to the public and insures better radio communication between France and the United States. Better still, the new station places Paris in direct touch with New York City, for the operator in Paris communicates directly with the operator in New York, without manual repeating. The Sainte Assise station has been constructed in remarkably short time, in view of its magnitude. On January 9, 1921, the first stone was laid. The antenna current of this powerful station ranges from 250 to 1000 kilowatts, depending upon the range to be covered and the transmitting conditions. The transmitting station is located on the plains of Sainte Assise, forty kilometers southeast of Paris. The transmitting equipment consists of two high-frequency alternators capable of delivering 500 kilowatts to the antenna. The receiving station is located at Villacresnes, halfway between Paris and Sainte Assise. It consists of six receiving units.

A Danger Not Fully Appreciated.—Recently in Cleveland, Ohio, a father, 48 years of age, and his son, 15 years of age, were killed in a tragedy brought on when an aerial touched a 2200-volt wire. In a hurry to set up a receiving set to hear a radio-phone concert, the young son, with the aid of another boy, who was seriously burned, had attached the aerial to the chimney of his house, and in so doing threw it over a high-tension wire. Not heeding the caution of other persons to tie a rope to the aerial, the young men clutched it. In the meantime friction of the aerial had rubbed off the insulation of the electric wire, a flash, the youth was killed instantly, and his father, who rushed to save him, died within a few minutes. This fatality should serve as a warning to others to be extremely careful in avoiding high-tension wires, and for that purpose this narrative is published. An aerial should never be stretched over or under electric light wires or other wires. It is dangerous practice. And it is inefficient practice, for wires are apt to induce troublesome noises which interfere with the reception of radio signals.

A Proposed British Radio Station.—The new transmitting station which the British Government proposes to erect at Bourne, in Lincolnshire, in connection with the Imperial Wireless Chain, will be the largest yet constructed in England. There will be eight steel masts, each 800 feet high. Owing to the fact that steel is a conductor, and therefore liable to cause a loss of electrical energy, the masts will be insulated in sections, and will stand on an insulating base. They will be guyed to concrete anchorages, and will be designed to take a horizontal pull of ten tons at the top and a wind load of sixty pounds per square foot. The masts will be arranged in the form of a square, in the center of which the transmitting station will be situated. The apparatus will consist of vacuum tube sets capable of transmitting continuously at ninety words a minute for reception in Poona, Johannesburg, or Perth, as the case may be. The new receiving station will be at Banbury, and will represent the other terminal of the Imperial Wireless Chain. It will be built along similar lines to the station already in existence there in connection with the Leafield-Abu Zabal (Egypt) link of the chain.

A Toll Radio-Phone Station.—A musical program will be given between 11 A. M. and 12 M and 4:30 and 5:30 P. M. week days over the new radio-phone broadcasting station WBAY, which was recently erected on the Walker Street Building of the American Telephone and Telegraph Company. A program will also be given on Thursday evenings from 7:30 P. M. to midnight, to be later announced. Such a station, which is intended for commercial broadcasting, has been assigned, for the present, by the United States Department of Commerce, a wave length of 360 meters. This does not permit simultaneous operating with the other broadcasting stations operating on the same wave length in this area. As a consequence the available hours have been assigned to the different stations operating in the vicinity of New York by an agreement between the stations themselves and with the approval of the Department of Commerce. The above schedule of two hours in the daytime and four and one-half on Thursday evenings is the temporary schedule which has been assigned to WBAY. Mr. A. W. Drake, general commercial manager, in charge of the station, states that there have been close to 100 applicants for the use of this station and that he has taken steps to arrange with these applicants for the programs which they will provide. While radio advertising has not as yet been prohibited by laws or regulations, it is considered, in the public interest, that applicants for the use of this station should provide programs of general interest. Until the details of the scheduling of private programs can be arranged, WBAY will continue to furnish miscellaneous musical selections.

Radio and the Central Station.—With the production and sale of electron tubes for use with radio sets already reaching 300,000 a month, the new prospect of energizing these tubes directly from the lighting socket makes the subject of radio of even greater interest to the central station company, states *Electrical World* in one of its recent editorials. The Bureau of Standards has now pointed out how vacuum tubes may be operated on the usual lighting current, thus doing away with troublesome storage batteries. And this brings up this thought: The most perplexing problem of the radio boom has been the question of how to finance the cost of broadcasting through revenue to be obtained from the receiving station that enjoys the service. So far no way has been found. Interesting possibilities are suggested, however, through the combining of carrier-current broadcasting over the lighting lines, as is now being done experimentally by General Squier in Washington, and this new use of central-station power in place of storage batteries. The consumption of energy by the receiving set, plugged into the nearest socket, would automatically provide a revenue directly creditable to broadcasting. This reasoning sounds good up to a certain point. It seems to us that if the filaments are operated directly from the socket, no storage batteries will have to be employed. Now storage batteries are used, and these must be recharged at regular intervals on lighting current. Inasmuch as storage batteries take far more current to recharge them than they actually deliver it would seem to us that the electric companies are now getting more revenue from radio than they might from the direct use of the current. The suggestion, however, is interesting.

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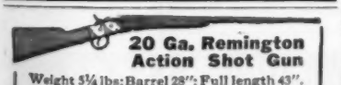

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(14414) C. S. I. asks: Is it possible for an object to float at any designated depth in fluid by the adjustment of buoyancy? Can conditions of equilibrium be maintained without motion or must the object be in motion with vanes to counteract its normal effort to reach the bottom or surface? For instance, will an object which once sinks beneath the surface continue—given unlimited depth to the bottom, or may it reach strata of balance and remain floating in it at a fixed depth, or does this factor of comparative incompressibility of liquid enter and make resultant forces nil? Can fluid pressure be compared with gas pressure? For instance, a gass-filled balloon will rise to a given height and, barring leakage, would remain there indefinitely, floating around in its strata of balance. A. It is extremely difficult, if not actually impossible, to adjust the buoyancy of an object, a submarine, for example, so that it will remain at a designated depth without motion. The tendency is for anything which sinks to go directly to the bottom, or for one that rises to rise directly to the surface. This tendency can only be controlled by constant adjustment of the buoyancy, taking in or ejecting water ballast usually. The comparative incompressibility of water makes it certain that any object which is heavier than water will go quite to the bottom anywhere. Water is only one-fifth denser at the greatest depth of the ocean than at the surface. If an object were but slightly heavier than water, less than one-fifth denser, it is conceivable that it might find a place where the density of the water were exactly the same as its own and it would float there. But this is quite unlikely. Most materials are much denser than water and so sink quite to the bottom. Gas pressure differs from liquid pressure in that a gas is compressible and easily expands as a balloon rises, so that ultimately the balloon comes to a place where the air has the same density as its own, and there it will float. To enable it to rise farther ballast is thrown out, and to bring it down gas is let out.

(14415) J. E. asks: (1). In using a transformer on a 220-volt line and stepping it down to 110 volts is the other 110 volts consumed in the wiring of the transformer, or where does it go? 2. What is the difference between a transformer and a rheostat? 3. If a rheostat and a 32-volt lamp were connected in series and a transformer and a 32-volt lamp were connected in series with a 110-volt line, which would consume the most current? A. 1. If a transformer changes an electric current from 220 to 110 volts the amperes of that current are at the same time doubled. A current is measured in watts, which are the product of volts and amperes. Except for a small percentage of transformer losses the watts of the current are the same after it goes through the transformer as they were before. For that reason if the volts are halved the amperes are doubled. 2. A rheostat uses up a portion of the current by adding resistance to the flow of the current. This is a direct loss. If the resistance of the rheostat is equal to the resistance of the rest of the circuit, then the voltage will be halved by the rheostat, and half of the voltage is lost by being changed into heat in the rheostat. It does no useful work. As we have explained above, a transformer changes the relation of the factors of a current, but leaves the product of these factors unchanged except for the loss in forcing the current through

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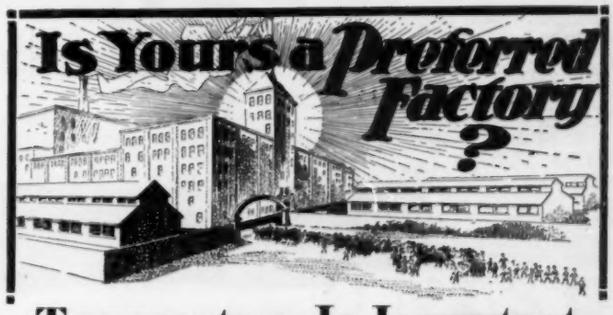

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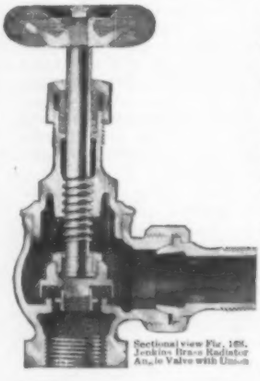

Sectional view Fig. 108, Jenkins Bros. Radiator Angle Valve with Union

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2374-J SINCE 1864

(14416) D. W. asks: (a) Is the speed of electricity definitely and positively known? (b) If so, what is it? (c) Can you state briefly what methods have been used for this purpose? (d) Is there any known method which would be practical for a small college to employ to measure the speed of electricity? A. (a) There is no definite speed of an electric current along a wire. The time required between any two points depends upon the electromotive force employed, the size of the wire and other factors. (b) The speed of electric waves has been determined to be the same as that of light; indeed, Maxwell proved that light is an electromagnetic phenomenon. Hertz's experiment determined the speed of these waves. The signals employed in wireless telegraphy furnish the mode used at present for determining the speed of electric waves. In the experiments to determine the difference of longitude between Arlington and Paris it was found that the signals required .021 seconds to pass from one place to the other. This gives a speed the same as that of light. (c) It would seem to be preferable for a small college to buy the books for its library which contain the work of those who have demonstrated these great truths than to put the very large sum into apparatus for repeating their work perhaps imperfectly. While this is true as a general statement, it may be there are exceptions to it.

(14417) C. M. K. asks: A. says there is no such a thing as a perfect vacuum. Is not the space in a barometer or thermometer above the mercury a perfect vacuum? A. The space over the mercury in a barometer is filled with vapor of mercury and is far from being a vacuum. In a thermometer there is always air over the mercury as well as vapor of mercury. Mercury is a liquid and will evaporate as other liquids do. It is said that there never was a perfect, absolute vacuum made. The mercury vapor in a barometer is a good conductor of electricity, and a vacuum is an insulator.

(14418) C. K. asks: 1. Will heavy objects such as iron, etc., sink to the bottom of the ocean where it is deepest? 2. Is there any place in the ocean where it is impossible to reach the bottom? 3. Say there was an explosion in a desert where there was no ear to hear, would there be a noise? A. 1. Any heavy body sinks in water and will go to the bottom anywhere, even where the ocean is deepest. Water is but slightly compressed by the greatest pressure upon it. At the bottom of the deepest places in the ocean the water is compressed only 1/5 and thus is far less dense than any heavy metal. The popular misconception on this matter arises from confounding pressure and density. The pressure of the water does not prevent sinking in it any more than does the pressure of the air prevent our falling in it. The air pressure on our bodies is roughly a ton per square foot, yet we fall swiftly through the air. The reason is that the pressure is equal in all directions and does not hinder motion through the fluid. The pressure of the water upon a fish does not hinder rapid motion through he water. The ill-fated "Titanic" went swiftly to the bottom and is not drifting about somewhere under the surface of the ocean, sustained by mere pressure. 2. There is no place known in the ocean where the sounding wire has not reached the bottom. The deep places in the ocean are called by the name of the ship from which they were discovered. The Planet Deep is 32,086 feet. This is six miles and 406 feet. 3. The answer to this question depends upon the definition of the word "sound." One definition is "A sensation in the ear;" another is "A vibratory motion which may cause a sensation of hearing in the ear." In the first sense there is no sound where there is no ear; in the second a sound exists whether it is heard or not. You may take your choice of definitions. There are frequent discussions and disputes over this question which could easily be settled without strife by consulting a dictionary.

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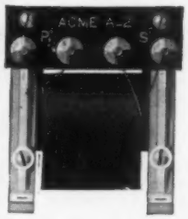

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Safes and Safe-Breakers—I

(*Continued from page 223*)

glars might make, so that no powder could be introduced. But the burglars simply drilled such safes through the front and back shells, ran a goose quill through and blew in the powder. Another manufacturer filled the shell of his safe door with water, but this was no more effective, for a small first drilling at the bottom let the packing run out and the safe met the same fate as before. One packing after the other was devised and tried, but the burglars seemed to like them all. This plan of defense had to be abandoned and attention was turned to case hardening in the hope that steel of sufficient hardness might be produced to turn the point of the drills.

This was the state of affairs in the late eighties and early nineties of the last century. Then came what seemed a decisive invention and complete victory for the safe-maker. A case-hardened steel safe called the Patent Champion and made by Herring, Hall and Marvin was introduced to banks and post offices, and greedily adopted by the men and institutions whose moneys had not been secure from the burglars. The old powder burglars with their steel drills encountered these safes and could make not the least impression. It was no use. The yegg was beaten at last.

Here was, in fact, the end of drilling in connection with safe burglary. It came at least twenty-five years ago, yet one reads continually in the newspapers and novels and where not of safes having been drilled and blown open. The gentlemen who write such fine material have simply not refreshed their information in a quarter century, or they would know that modern safes cannot be drilled; that modern burglars' methods require no drilling, and that the drill is not a tool now found in any safe blower's kit. The old Patent Champion attended to all that.

But if an inventor in America had beaten the drill and the powder burglar, another inventor in Sweden had devised the answering parry to this thrust some years before. You may recall that his name was Alfred Nobel, that he invented dynamite, which he egregiously expected to put an end to warfare, and that he left a fortune from which prizes are paid to the foremost contributors to civilization.

Dynamite came into common use in America some time before the days of the powder burglar were numbered, but it was not adopted by the criminals until a safe they could not drill forced them to look about for other methods of burglary. They soon lit upon dynamite, then being universally employed in quarrying, mining, excavation, railroad building and other construction work.

The Advent of Dynamite and the Debut of the Soup Yegg

The ordinary yegg knew nothing about dynamite in the beginning, except that it was an explosive much more powerful than powder and probably much more easily applied. However, there are always men of some sort of technical education who may be recruited to the underworld forces, and several such fellows now entered the ranks of the yeggs, because they saw abundant opportunity for larcenous operation. One after the other, the older and younger yeggs learned the use of the new explosive from these men and the country was shortly full of an improved order of safe blowers. The victory of the undrillable safe had been only a local success, soon converted into what came to assume the proportions of a rout. This adapted type of safe cracksman came to be called the soup yegg, from the fact that he employed "soup"—nitroglycerine extracted from dynamite. At least a rudimentary knowledge of technology and chemistry was apparently necessary to the new burglars.

The procuring and preparation of the new explosive for use in burglaries forms one of the most interesting parts of an account of safe robbing. The dynamite itself was not hard to get. It was stored with little care in magazines in almost every town in the country, wherever any kind of blasting was under way. The yeggs came at night, broke into the magazines and carried away a few sticks of the Nobel explosive, which would furnish them with enough soup to last a season.

The dynamite is carried to some hidden retreat in the woods and there converted. The process is simplicity itself and peril personified. The tools employed by the yeggs are a galvanized-iron water bucket, a large

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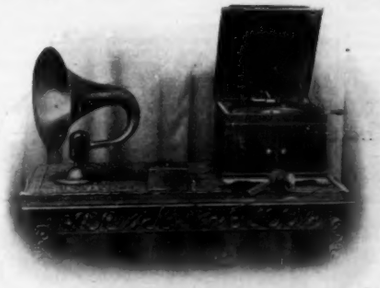

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syringe with a long nozzle, and a rubber hot-water bottle. The dynamite is first crumbled carefully between the fingers and let accumulate on a newspaper spread on the ground. This done, the bucket is partly filled with water from a nearby spring or stream, a primitive arrangement of two forked sticks and a crossbar is erected, and the bucket thus suspended over an open fire, made of twigs and dried wood. As soon as the water is about to boil, the crumbled dynamite is slipped into the bucket, where the hot water dissolves it, the sawdust and alien grease rising to the top and the heavier nitro-glycerine slaking to the bottom of the bucket. After five or ten minutes the top scum is skimmed off, the bucket is lifted to the ground and the soup-maker sucks the nitro-glycerine from the bottom with his long syringe and squirts it into the hot-water bottle. A few ounces are enough for a number of raids, and that quantity is all the robbers ever prepare at one time unless a master soup-maker is putting up a batch for several gangs.

Usually, however, every gang makes its own soup, and all its members are generally present at this hazardous operation, each and every one carrying away a splitting headache from the nitric acid fumes which arise. A good many robbers lost their lives in the distillation of this potent soup before the trick was fully mastered, and a good many more were blown to kingdom come before they learned how to carry the stuff about safely. At first it was put into glass bottles, but these frequently exploded and set off the charge either through sudden jars, through breaking of the bottle or through the accumulation of gases under a tight cork. At last it was discovered that a rubber bottle would not break, would expand with any rising gases and could be tied around the neck and carried under the shirt with five or six ounces of the perilous juice making hardly an obvious bulge. This came to be the accepted manner of transporting the safe-blower's extract.

One often hears it said that nitro-glycerine is effective against safes because of its great power, and the public generally accepts this as the explanation of the extraordinary rise in burglary which followed its adoption. But it was not the strength of nitro so much as its easy manner of application that made it a terror to the banker, the policeman and the safe builder. It is, of course, much more potent than any powder and it would have succeeded the earlier explosive on this score alone, but the main reason for its immediate and universal adoption was the fact that non-drillable safes had come into use and that nitro required no drilling. Even today there are still many safes in use which might be opened with powder—such safes as the yegg opens with a can opener or by knocking off the combination with a sledge and then pouring a little explosive into the hole. But nitro does all these jobs much more neatly, quietly and surely.

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So all safes, big or little, are now opened without drilling. The main use of nitro was, however, directed against the better, newer, burglar-proof safes, the kind used where larger amounts of money and other valuables are deposited, and the kind, incidentally, in which burglars have greater interest.

The general method of robbing such safes with nitro-glycerine needs to be understood, for the whole modern art of the cracksman rests upon it. The safe may be attacked in several ways, but the underlying principle is always the same. In some cases the burglar wishes to blow off the combination handle first, in order to get at the mechanics of the safe through the hole. In that case he applies his nitro to the cracks about this spindle. In other cases, the more common with modern safes, he wants to blow off the sheetings or casings of the safe door. In that event he applies his nitro to the crack where the door joins the wall of the safe.

The manner of applying the soup is simple. A cup of putty or common yellow soap is formed and stuck to the safe door at the point or against the crack where the explosion is desired. Into this cup the burglar pours a small quantity of the soup, varying with the strength of his extract and the quality of the safe. Perhaps a teaspoonful may be set down as the ordinary dose. This soup is then allowed to seep into the crevice. When it has nearly disappeared from the cup the burglar attaches a detonating cap, lights a short fuse and retires outside the building till the charge is exploded. One shot, as the burglar says, is usually enough for the ordinary safe or vault door, and it

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certainly was all that the "v" (vault) and "pete" (safe) of the nineties required. Inside the safe or vault there was usually a strongbox or kiester. This usually required another shot of nitro and sometimes more. But in the early days of its use the soup found few formidable obstacles, for the safe-maker had not anticipated any such novel and formidable foe. There was literally nothing between the yegg and his booty.

In the beginning there were a good many disasters among the yeggs, for numbers of inexperienced criminals undertook to use the soup without understanding its mysteries. They handled it loosely, with the result that there were premature explosions and missing hands and arms. Or they put too much into a safe, with the result that the thing was blown to pieces and the coveted money destroyed. In some cases so much nitro was used that a building was wrecked. The mangled body of many a bungling cracksman has been found to monument his inexperience.

But in a little time many scores of gangs of yeggs had mastered the use of soup and as they progressed they came to know more and more about safes and the manner of breaking them. Safe blowing with soup came to be a precise and absolute art before which the technical knowledge and inventive faculty of the safe-maker broke down and retreated. Nothing that could be turned out would stop the soup yegg. Banks and post offices all across the country attested to the scope of his victory. Safe-makers tried solid cast-steel doors, but these were worse than useless. They tried to fit doors so tightly that no nitro would seep into the joining, but the burglars employed fine wedges, opened a crack wide enough to admit their destructive juice and profited by the fact that the power of nitro is augmented by close confinement. Burglar-proof safes were then made of many sheetings of fine steel, so closely laid together that it was believed impossible to get nitro in between. But the yeggs blew these safes time and again, by shooting off one casing or steel layer after the other, till the inside of the safe was reached.

The dawn of this century found the safe-maker sorely beaten, whatever he may say about it. All his burglar-proof safes and time-lock safes and other burglar-proof safes were of no avail. They were all blown open as soon as experienced yeggs got round to them. Just as the Patent Champion seemed to defeat the old powder man and make an end of the yegg, so Mr. Nobel's dynamite had now defeated the maker of safes. It was the yegg's hour of fate.

THIS *ends the first part of Mr. Smith's article. The second part, dealing with the use of the oxy-acetylene torch and other modern methods of robbing safes, as well as the rise of defensive methods which render our large safes and vaults virtually impregnable, will appear in the November issue, published October 20.*—THE EDITOR.

The Planets for the Month

Mercury is an evening star at the beginning of October, setting at 6:16 P. M. and already lost in the twilight. On the 15th he passes behind the sun and becomes a morning star, running out rapidly to his greatest elongation on the 30th. At this time he is 18° 38′ from the sun, and more than 8° north thereof, and is well observable, rising just before 5 A. M. Saturn, which is about 5° northwest of him in the sky, rises earlier, but is almost a full magnitude fainter.

Venus is an evening star, in Libra and Scorpio, setting at 7:15 P. M. on the 1st, and 6:10 on the 31st. She is very bright, surpassing Sirius a dozen times, but is so far south that she is not so conspicuous as usual.

Mars is in quadrature with the sun on the 10th. Being more than 25° south of the equator, he sets about 10:30 P. M. and, even on that date, may fairly be called an evening star.

Jupiter is an evening star at the beginning of the month, setting at 6:20 P. M. and already lost to sight. On the 23rd he is in conjunction with the sun, but he does not become visible as a morning star until well on in November.

Saturn, too, is in conjunction with the sun on the 4th, but he comes into sight as a morning star at the end of the month.

Uranus is in Aquarius, crossing the meridian about 9 P. M. in the middle of the month, and practically invisible without a telescope. Neptune is in Cancer, observable, if at all, just before dawn.

The moon is full at 8 P. M. on the 5th, in her last quarter at 5 P. M. on the 13th, new at 9 P. M. on the 20th, and in her first quarter at 8 A. M. on the 27th.

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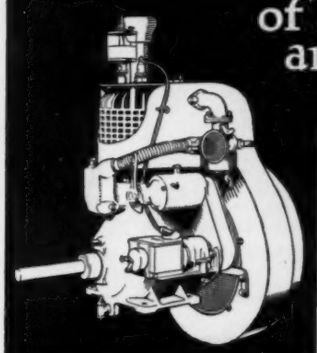

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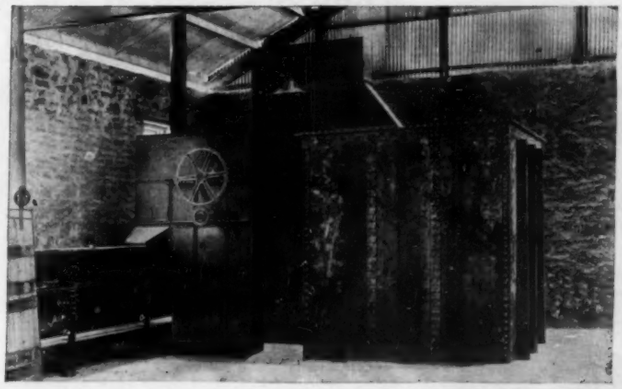

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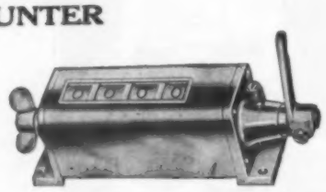

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The Spirit Photograph Fraud

(Continued from page 225)

spiritists want to see the spirit on the negative. Sometimes the picture of a spirit is made against a white background, and from the negative a "thin" positive is made, on a plate or film, and placed in a trick dark-slide immediately in front of the negative to be exposed. When this method is adopted the sitter is permitted to mark his plate in any way he chooses, and gets it back with a spirit extra. In this case both the negative and print have peculiarities that enable the investigator to identify the procedure; the spirit has the characteristic flatness of a copy, and the sitter's picture is fuzzy and lacking in definition. Another trick-slide method is that of exposing one-half only of a plate to the spirit, subsequently exposing the other half to the sitter, and with a skillful operator the result is a wonderfully good spirit picture. Here again the negative will give the clue to the method. The masking of the unexposed halves of the plate must be done carefully, and the line of division is usually covered by suitable background; it is frequently made to coincide with the vertical division between two stacks of bookcases. The result will hardly deceive an expert, however.

The most-used method is simple double exposure, usually to the spirit first, and in many cases against a dead black background of velvet, or some material that will not reflect light. In other instances the second exposure is to the spirit, and to show the degree of visibility—or so-called materialization—of the spirit is a mere matter of timing the exposure. It is seldom, however, that the spirit thus finds its way on to the plate with the second exposure—not that there is any photographic difficulty in this connection, as will be shown later; but now-a-day the spiritist wants to see the details, and usually follows the plate into the dark room after the exposure and there watches the development.

The degree of visibility—or materialization—is determined by the photographer, and depends somewhat on circumstances; it may not be wise for the spirit face to be very clearly defined. The limits of fake spirit photography are not reached when two exposures are made; the illustration of triple exposures, each taken in a different manner, show this. The head above and to the left of the sitter was in correct focus and had the first exposure; the one to the right was placed a little out of focus and a slight movement was given to it during exposure, consequently the features are not very plain and have the appearance of being only partly materialized. The plate was exposed for the third time to the sitter. In a second example (not shown herewith) an effort was made to give the spirit heads the appearance of being taken from lay figures. The effect is well marked and a little imagination will see both faces "radiant with ectoplasmic light." A careful examination of these examples of triple exposure will reveal practically no difference between the one in which the plate was exposed to the sitter first, and that in which the sitter was exposed last. With skill equally good negatives may be obtained either way, and it is difficult to determine the order of exposure by inspection of either negative or print.

Neither lay figures nor pictures were used in the spirit extras illustrated. In each case the spirit was taken directly from the living model. The negatives have not been retouched nor tampered with in any way, and in proof of this have been sent to the editor for inspection. (We regret that space is available for the reproduction of only one of these.—Editor.) To give the lie to the statement that spirit pictures can only be obtained on glass plates, gelatin plates (or films) were used to take all the illustrations accompanying this article, with the exception of the message from Jiggs, which was taken on an ordinary 3¼ x 4¼ glass plate.

In considering spirit photography one must not overlook the great advantage that is with the medium. He plays a game of "heads I win; tails you loose." If a sitter is too observant and a prepared spirit plate cannot be substituted, the test plate is exposed—with negative results. In these circumstances the medium does not lose caste; he can, and does, plead adverse conditions. Then at a subsequent sitting with a favorable opportunity the substitution is carried out, the spirit produced, and everyone is satisfied.

The spirit-photograph fake is probably the most despicable of all the fraudulent spiritist phenomena. Those seeking pictures are usually folk who have lost someone near and dear to them. Imagine them sitting with a canting psalm-singing humbug of the type of William Hope, who goes through the mockery of a religious ceremony, invoking the aid of the Almighty to get in touch with the spirits, knowing full well the spirit is already made and carefully planted, ready to be foisted upon his dupes when suitable opportunity offers! Hope and other like humbugs belong in the penitentiary.

All spirit photography is fraudulent. There is no spirit picture that has been produced by any medium — *anywhere* — the like of which cannot be produced by a skillful photographer, and without any psychic aid or influence. During the sixty years spirit photography has been before the public there is not a single instance of a spirit picture's being obtained when trickery was made impossible for the operator; in such circumstances no medium can get results. This I believe to be equally true of any other physical manifestation of psychic phenomena—eliminate the possibility of trickery and the phenomena are eliminated also. The recent negative results of the experiments conducted by the Sorbonne Laboratory of the University of Paris, with Eva Carriere, of ectoplasm fame, afford another proof of the fact.

The writer is not a particularly skillful photographer and wishes to acknowledge the valuable assistance afforded him by Mr. W. S. Holland in the production of the spirit pictures. It is to be hoped that neither Mr. Holland, nor the writer, will be accused, as Buguet was, of being genuine photographic mediums who have prostituted their talents for the purpose of discrediting the spiritist movement!

The Thunderbolts of Peace

(Continued from page 249)

points are embedded in the fulminate mixture and the top of the cap is sealed by melted sulfur or similar material. Specially constructed blasting machines are made by explosives manufacturers for the purpose of firing these electric blasting caps in mines varying from those designed to fire one cap at a time to the larger sizes which will fire up to 150 at a time.

Electric firing makes possible the simultaneous firing of several charges of dynamite and the absolute control of the time when the firing takes place. In blasting a stump by the roadside, for instance, if you place the charge and light the fuse and retire to a safe distance, and someone drives along the road at about the time the stump is due to go up into the air, you are out of luck, whereas with electric firing, if you see the vehicle in time you can perfectly well wait until it is in a safe place before firing the charge. In quarry and construction work where thousands of pounds of dynamite are fired at one time, and many hundred thousands of tons of rock thrown down, the simultaneous firing of a large number of bore holes charged with dynamite makes the most economical method of using high explosives.

Galvanometers, which are really small direct-reading ohmmeters, are sold to quarrymen and contractors for testing electric blasting caps and electric blasting-cap circuits. By this instrument it is possible to determine positively that there are no breaks, short circuits, bad connections or electric leaks in the circuit, so that if the blasting machine is in good condition and properly operated the blast will surely be a success, whereas with cap and fuse you have to take the condition of the fuse and the condition of the cap on faith and hope for the best.

It is possible to fire black powder electrically by means of a device known as the electric squib. This operates on the same principle as an electric blasting cap, except that it does not detonate but merely shoots out a small flame big enough to ignite the blasting powder. In this way several charges of blasting powder can be fired simultaneously, and any charge can be ignited in the center of the charge instead of at the end, and this makes for greater efficiency.

One of the later agents for detonating high explosives is cordeau, which consists of a small lead pipe or tube filled with T. N. T. This is quite insensitive to pinching, hammering or friction, and can be fired only by means of a detonator. It is used with great satisfaction in firing large charges of dynamite simultaneously. The cordeau line runs clear to the bottom of each blast hole and the charge of dynamite is packed in around it. The exposed ends of the cordeau lines in each blast hole are each in turn connected with another line of cordeau which runs

along the surface of the ground directly over the bore holes. At one end of this trunk line a blasting cap or electric blasting cap is attached by a special connector, and when this cap is fired the trunk line of cordeau detonates and transmits this detonation to each line of cordeau extending into the bore holes, and this in turn detonates the dynamite. The velocity of detonation of this cordeau is about 17,000 feet per second. It has the advantage of electric firing in that the entire length of the charge of dynamite in the blast hole is acted upon by the detonation of the cordeau, instead of merely the one or more points in the charge where the electric blasting caps would be placed.

Metal-mining consumes by far the greatest amount of explosives in the United States; coal mining is second; and then come quarry, railroad and canal construction work and agricultural purposes. The latter heading includes stump blasting, ditching, sub-soiling, tree planting, and road-construction work in the lumber camps. The low-freezing ammonia powders are the most popular of all types. Nearly as many pounds of these are made as of all other brands put together. They are used in iron mining, quarry and construction work, and wherever the ventilation is good and not much water is encountered. Gelatins are most popular for mining hard ores and for all kinds of work underground where the ventilation is deficient and where work is carried on at high speed. Gelatins have the property of plasticity, which enables the miner to make the cartridges stick in holes which are drilled upward, a very great advantage in stoping and raised work in metal mining. They are almost unaffected by water and the fumes are relatively inoffensive. Gelatin is used almost exclusively for submarine work like harbor excavations. The largest quarries in the country are using low-freezing ammonia powders, although where the rock is very hard a tough gelatin is preferred on account of its high density, i.e., it is possible to concentrate in a small space the maximum weight of explosive energy. In railroad and canal construction work, known in the trade as contracting, the preference is largely for the comparatively old-fashioned straight dynamites. These are the quickest-acting and most shattering, stand water well, but are not particularly notable for good fumes.

The agricultural use of explosives is one of the most interesting, and, from the manufacturer's standpoint, one of the most promising, as there is more chance of an increase in explosives consumption in this field than in any other. Outside of clearing roadways in the lumber camps and in road construction, both of which are classified as agricultural work, the biggest field for the agricultural use of explosives is in blowing out stumps and digging ditches. By what is known as the propagation method, it is possible to blow a ditch through a tangle of briers, weeds, shrubs and creepers in marshy, swampy land much more quickly and more economically than by any other method. Fifty or sixty per cent straight dynamite is used for this purpose, one or more cartridges placed in each hole, the holes being punched with an iron bar in the ground about 18 to 24 inches apart and in the line of the desired ditch. In one of the holes, usually about the center, one or two extra cartridges of dynamite are placed, one of them primed with a cap and fuse. When this central hole is fired the concussion or shock of the explosion explodes the holes on each side, which, in turn, communicate this shock to adjacent holes almost instantaneously, so that the entire line of charges explodes at practically the same time. This blows the dirt high into the air in a fine spray, which falls clear of the ditch, leaving it open and free for the flow of water. This method is possible only where the soil is very wet and free from sand, as sand cushions the shock of the dynamite and prevents transmission. Where ditches have to be made by blasting through dry soil or sand, an electric blasting cap must be placed in each charge and these caps fired by means of a blasting machine.

Clearing land of stumps in cut-over regions in the Northwest has been one of the largest sources of explosives consumption for agricultural purposes, and the blowing out of stumps by means of dynamite is one of the best known of the agricultural uses of high explosives. Immense tracts of cut-over land exist in Wisconsin, Michigan, and Minnesota, and in the Pacific Northwest. These tracts are taken up by farmers, who blow out the stumps with dynamite and raise valuable crops. In some parts of the South explosives are used in carload quantities for blowing out the rich resinous stumps of the long-leaf yellow pine. Here it is the stump that is the valuable commodity, not the land, as these stumps are rich in turpentine and are sold to the distilleries in normal times at a profit.

Tree planting with dynamite has proved extremely profitable to the orchardists, and millions of pounds of dynamite have been used for this purpose. Small charges of dynamite, one-quarter to one-half pound, are fired when the soil is dry at the depth of about 30 inches. This shakes up and loosens the surrounding soil so thoroughly that when the young tree is planted its root growth is greatly facilitated, and the tree comes into bearing a year or two earlier than trees which are planted in holes not so treated. The shaking up and aerating of the earth around old orchard trees usually results in the rejuvenation of the tree so that apple trees which have borne no fruit for several years have taken on a new lease of life.

In the rolling country of the South, such as Georgia and the Carolinas, explosives have been used very successfully for controlling erosion. By loosening up the soil it is made possible for the water from the heavy rainfalls to soak into the earth, instead of running off and carrying away the top surface of the land.

Other miscellaneous uses of explosives outside of road building, which is really in the field of the construction contractor, are blasting out boulders, blasting holes to place post holes and telegraph poles, sinking wells, shooting deep wells to increase the flow of water, and increasing drainage by firing subsoil shots between lines of tile drains. There are a large number of other uses of explosives outside of the mining, quarrying, and agricultural fields which might be termed emergency uses or freak uses. Among these are starting log jams and blasting ice gorges to release or prevent floods; the extermination of mosquitoes by the ditching and drainage of swamps; the killing of woodchucks, prairie dogs, ground gophers and other burrowing animals; shooting sharks for their valuable leather; blasting out ponds to kill undesirable fish, such as carp; stampeding fish into seines; razing buildings, smoke-stacks and the like; demolishing concrete foundations in standing buildings, under turntables and bridge piers; breaking up steel skulls and crosses in blasting furnaces; blowing out nuts and bolts which have become tight in various kinds of machinery; blowing open safes, which does not sound like legitimate operation, but is one which we are called upon to do by safe manufacturers and after fires; breaking up wrecked ships and wrecked bridges; controlling forest fires; blowing out oil well fires; blowing down whole blocks of houses in vast conflagrations like the San Francisco fire and the fire at Atlanta, Georgia; and even such uses as making smoke screens and artificial geysers and shell explosions for the movies. Indeed, the list of useful purposes for which explosives are employed grows day by day and so also does our knowledge of the nature of explosive compounds and the methods by which their potential energy can be applied and controlled.

The Twenty-Hour Week

(*Continued from page 253*)

siding. For if they are not, the saturation point is reached in a very short time, when all the mine-cars are loaded, with no place available to unload them.

Now, the mine superintendent feels toward the railroad exactly as the miner feels toward the mine management—that it's not worth while hanging around and waiting for cars that may arrive and may not. And on the other hand, the railroad is in much the same predicament, as regards the supply of flats to the mine, as is the mine with regard to supplying mine-cars to the headings. The railroad cannot make cars sprout out of the ground; it has to bring them to the mine, and to scores of other mines, over a track that is carrying a lot of other business. Without putting concrete responsibility upon any definite person or in any definite place, the fact is that experience justifies the mine superintendent in refusing to open the mine at all when there are no flats on his siding—no matter what the railroad representative may tell him about their imminent arrival; and the same experience justifies the miners in refusing to go into the pits, even on the definite promise of flats in fifteen minutes. The miner finds it anything but a joke to crawl a mile to his heading, and then to crawl back without the opportunity to

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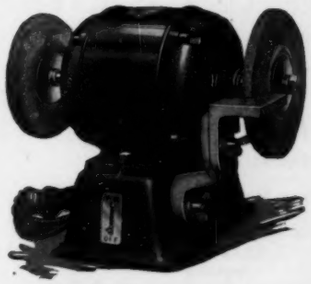

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*

The makers of U. S. Tires were first to conceive, make and announce a *complete line* of tires. (This gave to the dealer and car-owner something that never existed before—a tire for every need of price and use under *one standard of quality.*)

The makers of U. S. Tires were first to have the courage to tell the public about the good and bad in the tire-retailing. (You remember the phrase "Go to a legitimate dealer and get a legitimate tire." People can no longer take the indifferent stand that "discounts," "inside terms" and "dickers" are a necessary evil in the tire business.)

The makers of U. S. Tires were first to arouse industrial and trade minds to the need of a *new kind* of tire competition. (Competition for better and better *values.* Greater and greater public confidence. The job is still unfinished but present events predict final returns of *public benefit.*)

* * *

STILL other high spots along the U. S. Tire road to leadership may appeal to you as even more important.

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Now that so many car-owners have given their verdict for quality tires in general, and U. S. Tires in particular—a number of dealers and car-owners whose vision has been clouded by "discounts," "sales," "terms" and what not, are beginning to remember that they "knew him when he was a boy."

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